SEP 20 1917
Engineering Library
UNIV. OF [illegible] LIBRARY

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C. 2

VOL. CIV.—No. 2696.] *LONDON: FRIDAY, AUGUST 31, 1917.* [*Registered at the General Post Office as a Newspaper.*] [PRICE...8d. BY INLAND POST...10d.

Aveling & Porter, Ltd.,
ROCHESTER, KENT.
and 73, CANNON STREET, LONDON.
STEAM ROLLERS. ROAD LOCOMOTIVES.
STEAM CULTIVATING MACHINERY.
STEAM WAGONS. TRACTORS.
CEMENT-MAKING MACHINERY. 6030

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See Advertisement, page 29.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Cement.—Maxted & Knott,
LTD., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest references. Established 1880.
Address, BURNETT AVENUE, HULL.
Cablegrams: "Energy, Hull." 5234

Cranes.—Electric, Steam,
HYDRAULIC and HAND.
of all types and sizes.
GEORGE RUSSELL & CO., LTD.,
Motherwell, near Glasgow. 5697

STEEL TANKS, PIPES, GASHOLDERS, &c.

Thos. Piggott & Co., Limited,
BIRMINGHAM. 4457
See Advertisement last week, page 100.

Plenty and Son,
LIMITED.
MARINE ENGINEERS, &c.
NEWBURY, ENGLAND. 9963

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO., LTD.,
ENGINEERS, NEWCASTLE-ON-TYNE. 5699

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON AND TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORKS, also CAST-STEEL AXLE BOXES. 5769

P. & W. MacLellan, Limited,
CLUTHA WORKS, GLASGOW,
MANUFACTURERS OF
RAILWAY CARRIAGES AND WAGONS, OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, GLASGOW. Od 3547
Registered Offices: 103A, Cannon St., London, E.C.

Fuller, Horsey, Sons & Cassell,
SPECIALISTS
in the
SALE AND VALUATION
of
PLANT AND MACHINERY
and
ENGINEERING WORKS.
133, HIGH HOLBORN, LONDON, W.C. 1.

Invincible Gauge Glasses.
BUTTERWORTH BROS., Ltd.,
Newton Heath Glass Works,
Manchester. Od 9743

Iron and Steel
Tubes and Fittings.
5143
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 94, Robertson Street, Glasgow.

Yarrow & Co., Ltd.,
SHIPBUILDERS AND ENGINEERS,
GLASGOW (formerly of POPLAR, LONDON).
SPEEDS UP TO 45 MILES AN HOUR.
PADDLE OR SCREW STEAMERS OF
Exceptional Shallow Draught
VESSELS PROPELLED BY STEAM
Turbines or 6093
Internal Combustion Engines.

Campbells & Hunter, Ltd.
Gear Cutting.
Worm Wheels cut up to 13 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
DOLPHIN FOUNDRY, LEEDS. 4547

Yachts, Launches, or Barges,
Built complete with Steam, Oil or Petrol Motors, ; or Machinery supplied. Od 3551
VOSPER & CO., LTD., BROAD STREET, PORTSMOUTH.

FOR
Sheet Metal Stampings or PRESSINGS
write
GARTSHERRIE ENGINEERING & FORGE CO.,
50, WELLINGTON STREET, GLASGOW. 6305

Oil Fuel Appliances.
SYSTEMS { PRESSURE. AIR. STEAM.
FOR BOILERS OF ALL TYPES.
Kermodes Limited,
3, THE TEMPLE, DALE STREET, LIVERPOOL;
and
109, FENCHURCH STREET, LONDON. 4078
NAVAL OUTFITS A SPECIALTY.

Locomotives Tank Engines designed and constructed by MANNING, WARDLE AND COMPANY, LIMITED, Boyne Engine Works, Leeds. Od 2457
See their Illus. Advertisement, page 171, last week.

Cochran MULTITUBULAR AND CROSS-TUBE TYPES.
Boilers.
See page 102, Aug. 24. 5754

Punch and Shear Machine SPECIALISTS. 4784
Consult us. "The Best and the Cheapest." Large Stock. Satisfaction Guaranteed. Established 1860.
SCOTT BROS., WEST MOUNT, HALIFAX.

"Gripoly"
MACHINE BELTING
FOR
Driving
Conveying
Elevating
SOLE MANUFACTURERS
Lewis & Tylor, Ltd.,
CARDIFF. 5434
LONDON. MANCHESTER. GLASGOW.

Rubber Stamps, Stencils, Steel Punches, Brands, Wages Boxes, Pay Checks, Automatic Numberers and Dates for Munition Factories, &c.
Stencil Ink, all Colours, in Stock. 6082
ASH RUBBER STAMP CO., LTD.,
102, Constitution Hill, Birmingham.
Telephone—Central 786. Telegrams—"SIDASH."

John Bellamy, Limited,
MILLWALL, LONDON, E. 1216
GENERAL CONSTRUCTIONAL ENGINEERS.
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETED STEAM AND VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Tubes, Iron and Steel.
Edwin Lewis & Sons, Ltd.,
Wolverhampton. 5626

Tubes and Fittings.
Stewarts and Lloyds, Ltd.,
Glasgow and Birmingham.
See Advertisement page 74. 5101

Rubber MANUFACTURERS.
Hose Suction and Fire.
GUTTA PERCHA & RUBBER, LIMITED,
Toronto - - Canada. 5918

CO^2 Plants (CARBON DI-OXIDE)
for Chemical & Mineral Water Mfrs. & Breweries.
READ & CAMPBELL, Ltd., 109, Victoria St., London, S.W. Telegrams—"Valorem, London."

CO^2 Fire Extincteurs
for Public and Private Bldgs., Electric Railways, &c.
THE BRITISH FIRE APPLIANCES Co., Ltd., 109, Victoria St., London, S.W. Telegrams—"Nonacid, London."
THE WELL-KNOWN
Fine Red Moulding Sand,
FOR
IRON, BRASS, ALUMINIUM.
APPLY,
Mansfield Sand Co., Ltd.,
MANSFIELD, NOTTS. 5175

Two Motor-Generators, Westinghouse. Motor three-phase, 50 periods. Generator 500 volts.
One A.C. Motor 300 HP., three-phase, 50 periods.
One D.C. MOTOR or GENERATOR, 375 r.p.m., 200 Kw., at 440/550 volts.
One Two-phase 200 Kw. GENERATOR, 50 periods, 2300 volts, but could be readily altered for other voltages.
JENNINGS,
West Walls, Newcastle-on-Tyne. 6045

THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS and EVERY OTHER DESCRIPTION OF RAILWAY & TRAMWAY ROLLING STOCK.
Makers of WHEELS & AXLES, RAILWAY PLANT, FORGING, SMITH WORK, IRON AND BRASS CASTINGS.
Registered Office and Chief Works: Motherwell.
Cardiff Office: Gordon Chambers, St. Queen Street.
London Office: 14, Leadenhall Street, E.C.
See Illustrated Advt. in alternate issues. Od 2382

R. Y. Pickering & Co., Ltd.,
(ESTABLISHED 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS.
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices
WISHAW, near GLASGOW.
London Office:
3, VICTORIA STREET, WESTMINSTER, S.W. 6210

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS. 6069
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, LTD., FRIARS HOUSE, 39-41, NEW BROAD ST., LONDON, E.C.
See half-page Advertisement, last and next week.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER,
FEED WATER HEATERS,
CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM AND GAS KETTLES. } ROW'S PATENTS.
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5128

Yarrow Patent
Water-tube Boilers.
6094
MESSRS. YARROW & CO., UNDERTAKE the PRESSING and MACHINING of the various parts of Yarrow Boilers, such as the Steam Drums, Water Pockets, and Superheaters for British and Foreign Firms not having the necessary facilities.
YARROW & CO., LTD., SCOTSTOUN, GLASGOW.

Matthew Paul & Co., Ltd.
LEVENFORD WORKS, **Dumbarton.** 6054
See Full Page Advt., page 36, Aug. 24.

Forgings.
Walter Somers & Co., Ltd.,
HALESOWEN. 5649

For Sale, Root's Blower.
A 5 in., with ring oiling bearings, fast and loose pulleys.
For Immediate Disposal.
H. J. H. KING & CO., LTD., Engineers, Nailsworth, Glos. R 426

Taylor & Challen
Presses.
3106
Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED,
DARLINGTON. 6207

RAILWAY CARRIAGES, ELECTRIC CARS, &c.
Hurst, Nelson & Co., Ltd.
THE GLASGOW ROLLING STOCK AND PLANT WORKS,
MOTHERWELL. Od 2382

Delta Metals. HIGH-CLASS ENGINEERING ALLOYS.
Forgings, Castings, Bars, Sheets, Wire, Tubes.
THE DELTA METAL CO., LTD., 5606
EAST GREENWICH, LONDON, S.E. (And Birmingham)

Improved High Pressure
RENEWABLE DISC GLOBE VALVE.
See our Advertisement in last week's issue, page 35.
BRITISH STEAM SPECIALITIES, LTD.,
Bedford Street, Leicester. 3020

Machine and Engineering
WORK of all description undertaken for Manufacturers, Patentees, &c. Also repairs and renewals. Best work, moderate charges.—ROSSER & RUSSELL, LTD., Queen's Wharf, Hammersmith.
NEW PATENT ACT.—ROSSER & RUSSELL, Ltd., are prepared to undertake the manufacture of articles at present made abroad, and will be pleased to hear from firms desiring such work executed. 2211

CHANTIERS & ATELIERS
Augustin - Normand
67, rue de Ferrey—LE HAVRE
(France.)
3090
Destroyers, Torpedo Boats, Yachts and Fast Boats.
Submarine and Submersible Boats.
NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND.
5466
See half-page Advertisement page 76, Aug. 10.

The Manchester Steam Users' ASSOCIATION.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, Mount Street, Manchester.

Chief Engineer: C. E. Stromeyer, M.I.C.E.

Founded 1854 by Sir William Fairbairn.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 5864

South-Western Polytechnic INSTITUTE, CHELSEA, S.W. 3.

UNIVERSITY and TECHNICAL DAY and EVENING COURSES in MECHANICAL and ELECTRICAL ENGINEERING commence 24th September, 1917.

Scholarship Examination, 17th September, Ten a.m.

Apprenticeship Scheme for Engineers.

Prospectus on application to the SECRETARY (Room 24).

Telephone: 209 Western. H 451

UNIVERSITY OF DURHAM.

Armstrong College, NEWCASTLE-UPON-TYNE.

PRINCIPAL—W. H. HADOW, M.A., D.Mus., J.P.

SESSION 1917-18.

COMMENCING 24th SEPTEMBER, 1917.

Departments of MECHANICAL, MARINE, CIVIL and ELECTRICAL ENGINEERING, NAVAL ARCHITECTURE, MINING, METALLURGY, AGRICULTURE, and of PURE SCIENCE, ARTS and COMMERCE.

Full particulars may be obtained on application to—
F. H. FRURN, M.A., Secretary.
Armstrong College, Newcastle-upon-Tyne. 6186

University of Manchester.

DEPARTMENT OF ELECTRICAL ENGINEERING.

DEPARTMENTS OF CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

Full particulars of these Courses will be forwarded on application to the REGISTRAR.
The Session COMMENCES on the 4th OCTOBER. H 612

The University of Sheffield.

SESSION 1917-1918.

Vice-Chancellor: W. RIPPER, D.Eng., D.Sc., M.Inst.C.E., J.P.

DEPARTMENT OF APPLIED SCIENCE, COMPRISING FACULTIES OF ENGINEERING AND METALLURGY.

PROFESSORS IN THE DEPARTMENT.

Mechanical Engineering—W. RIPPER, D. Eng., D.Sc., M.Inst.C.E.
Metallurgy—J. O. ARNOLD, D.Met., F.R.S.
Mining—J. E. ARMSTRONG, M.Sc., A.M.Inst. C.E.
Applied Chemistry—L. T. O'SHEA, M.Sc.
Mathematics—A. H. LEAKY, M.A.
Physics—S. R. MILNER, D.Sc. (Acting Prof.).
Chemistry—W. P. WYNNE, D.Sc., F.R.S.
Geology—W. G. FEARNSIDES, M.A.

Electrical Engineering—H. H. CRAPPER, B.Eng., M.I.E.E. (Lecturer).
Civil Engineering—J. HUSBAND, B.Eng., A.M.Inst. C.E. (Lecturer).
Glass Technology—W. E. S. TURNER, D.Sc. (Lecturer).

The subjects in which Courses of study are provided include Engineering, Metallurgy, Coal Mining, Applied Chemistry, Mathematics, Physics, Chemistry, Geology and Glass Technology.

The DEPARTMENT OF ENGINEERING includes Courses in Civil, Mechanical, Electrical and Chemical Engineering, and Students specialise in one or other of these branches in the third year of their Course. The Course in Engineering extends over three years and prepares for the Degree of Bachelor of Engineering (B.Eng.) or for the Associateship of the University in Engineering. Special three years' Courses are arranged for Works' Pupils, who come to the University from Works in Sheffield or from other centres, taking six months' study at the University and six months' practice at the Works each year.

The DEPARTMENT OF METALLURGY includes (a) the Metallurgy of Iron and Steel, and (b) the Metallurgy of the Non-ferrous Metals. The Course in Metallurgy extends over three years, and prepares for the Degree of Bachelor of Metallurgy (B.Met.) or for the Associateship of the University in Metallurgy. The equipment of this department is on an exceptionally complete and practical scale.

The work of the DEPARTMENT OF COAL MINING includes a three or four years' Diploma Course, consisting of six months at the University and six months at a colliery.

The DEPARTMENT OF APPLIED CHEMISTRY deals specially with the subjects relating to various branches of Coal Mining, and of the Coal and Coke Industries.

The DEPARTMENT OF GLASS TECHNOLOGY provides (a) a Diploma Course requiring systematic study of the science and practice of Glass Manufacture, for a period of three years, and (b) Part Time and Special Courses.

The LECTURE COURSES of all the Departments are supplemented by Practical Training in Laboratories, Workshops and Foundries fully equipped for the purpose of advanced scientific teaching, investigation and research.

Part Time Courses are arranged for Students who desire to take special portions of any of the regular Courses.

The LECTURE COURSES commence 3rd October, 1917.

The TECHNICAL LABORATORY COURSES commence 24th September, 1917. H 114

W. M. GIBBONS, Registrar.

University of Bristol.

FACULTY OF ENGINEERING.

DEAN—
Prof. J. WERTHEIMER, B.A., D.Sc., F.I.C.
Civil Engineering—Prof. R. M. FERRIER, M.Sc., M.Inst.C.E.
Mechanical Engineering—Prof. J. MUNRO, M.Sc., M.I.Mech.E.
Electrical Engineering—Prof. D. ROBERTSON, D.Sc., M.I.E.E.
Automobile Engineering—Prof. W. MORGAN, B.Sc., M.I.A.E.

Fee, £36 6s. a year, but may be reduced to not less than £15 15s. for students whose parents' incomes are under £350 a year.

Prospectus from the Registrar. H 603

City and Guilds Technical COLLEGE, FINSBURY.

(LEONARD STREET, LONDON, E.C. 2)

CIVIL AND MECHANICAL ENGINEERING.
Prof. MARGETSON, M.Sc.
ELECTRICAL ENGINEERING.
Prof. W. ECCLES, D.Sc., A.R.C.S., M.I.M.E.
APPLIED CHEMISTRY.
Prof. G. T. MORGAN, D.Sc., F.R.S.

The training is adapted to the needs of pupils from Secondary Schools above the age of 15, and men who, having previously served a pupilage or apprenticeship in works, desire to go through a more systematic training.

The College contains laboratories and workshops equipped for instructional purposes, including Engineering and Hydraulic Laboratories, Drawing Offices, Wood and Metal Workshops, Mechanics, Physics, Electrical and Chemical Laboratories, and Dynamo Rooms.

A considerable extension of the Chemical Laboratories for Research, and for the special consideration of Processes of Manufacture, has recently been made.

The next Entrance Examination will be held on September 18th, in the subjects of Mathematics and English, but the Matriculation Examination of any British University is accepted instead.

The fees are £30 per annum.

The Programme giving particulars of Admission, Entrance Examination, Syllabuses of Instruction, and other information, may be had post free on application to the REGISTRAR of the College at the above address. H 638

Crystal Palace School of PRACTICAL ENGINEERING.

Principal: J. W. WILSON, M.Inst.C.E., M.I.Mech.E. Established 1872.

The New Course will COMMENCE on Sept. 12th. New Students are entered on Sept. 11th (Morning). Prospectus from the Principal. H 649

Inst. C.E., I. Mech.E., B.Sc., and all Engineering Examinations.

—Mr. G. P. KNOWLES, B.Sc., Assoc. M. Inst. C.E., F.S.I., M.R. San. I., PREPARES CANDIDATES personally or by correspondence. Hundreds of successes. Courses may commence at any time.—39, Victoria St., Westminster, S.W. 6157

TENDERS.

OLDHAM CORPORATION ELECTRICITY WORKS.

PLANT FOR SALE.

The Oldham Corporation Electricity Committee

Offer for Sale the following

PLANT:—
Two Willans-Siemens 740 Kw. Sets, Shunt Wound, 450-490 volts.

The plant is in good working condition, and can be seen by appointment.

Further particulars can be obtained from MR. P. L. OGDEN, Joint Engineer and Manager, Electricity Works, Greenhill, Oldham.

The highest or any Tender not necessarily accepted.

J. H. HALLSWORTH,
Town Clerk.
Town Hall, Oldham. H 506

APPOINTMENTS OPEN.

LONDON COUNTY COUNCIL.

APPOINTMENT OF CHARGE SHIFT ENGINEER.

The Council invites

Applications for the Position

of CHARGE SHIFT ENGINEER at the Tramways Electricity Generating Station at East Greenwich, at a commencing yearly salary of £350, rising by £10 a year to £300 a year.

Applications must be on the official form, which specifies the conditions upon which the appointment will be held. A stamped addressed foolscap envelope must be sent with the request for the form of application, which may be obtained from the Clerk of the Council, County Hall, Spring Gardens, S.W. 1, and must be returned not later than One p.m. on 24th September, 1917.

JAMES BIRD, H 653
Clerk of the London County Council.

Required for the Service of

the Government of India, in the Gun and Shell Factory, Gossipore, Five ASSISTANT FOREMEN, between 24 and 30 years of age, physically fit for service in India and qualified as follows:—

One To act as Assistant Electrical Engineer.

One First Class Turner acquainted with shell machining.

One Draughtsman to take charge of Drawing Office. Must possess certificates in mechanical engineering subjects.

Two Experienced in the manufacture of Fuzes, and able to make own gauges and tools.

All candidates must make sure that they could be released from their present employment, if selected.

Terms.—Engagement for five years with option of extension if approved by Government. Salary 280 rupees per month rising by annual increments of 10 rupees per month to 330 rupees per month. If re-engaged, 350 rupees per month. Overtime pay will be granted on certain condition. Free quarters, medical attendance and 2nd class passage out and home for selected candidate, wife and family.

Further particulars and forms of application can be obtained from the DIRECTOR-GENERAL OF STORES, India Office, Whitehall, S.W. 1. H 605

SUNDERLAND EDUCATION COMMITTEE.

THE TECHNICAL COLLEGE.

The Governors invite Applications for the post of temporary LECTURER

in Practical Mathematics during the ensuing Session October 1st, 1917, to April 30th, 1918. A well fitted Laboratory is attached to the department, and the day courses are of University standard and suited to the needs of Mechanical and Electrical Engineering Students attending a complete four years' course in Mathematics, Mechanics and Practical Geometry. Salary for the Session, £200 to £250, depending upon experience and qualifications. Candidates must be ineligible for military service. Further particulars can be obtained from the Principal. Applications with copies of three recent testimonials, must be received by the undersigned on or before the first post on Wednesday, September 12th.

HERBERT REED,
Education Office, Secretary.
15, John Street, Sunderland.
28th August, 1917. H 643

The Port of London Authority

REQUIRE the services on the temporary staff of several DRAUGHTSMEN thoroughly experienced in the design and construction of one or more of the following branches of engineering:—

(a) Heavy moveable bridges and steelwork.
(b) Lock Gates and Caissons.
(c) Docks, entrances, passages, walls, jetties, &c.
(d) Railways.
(e) Mechanical appliances.
(f) Hydraulic installations.

State age and salary required, medical category (if of recruitable age), present salary and employment and when at liberty.—Apply by letter only to the CHIEF ENGINEER, 109, Leadenhall Street, E.C. 3. H 651

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

POST OF ORGANISING SECRETARY.

The Representative Council of the Association of Engineering and Shipbuilding Draughtsmen invite

Applications for the Post of GENERAL SECRETARY.

The salary attached to the post is £350 per annum rising by increments of £25 to a probable maximum of £400.

The successful candidate must be prepared to give his entire services to the Office and to reside in Glasgow until 1st March, 1918, when headquarters will be removed to London.

Six months' notice in writing to terminate the agreement on either side.

Applications should state age, qualifications and organising ability, and six copies should be forwarded not later than 21st September, to the SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 94, Hope Street, Glasgow. Envelopes to be marked "G.S." H 661

Manager Wanted, for the Midlands.

Thoroughly competent to undertake control of the manufacture of Milling Cutters, Reamers, Hobs, Gear Cutters, &c., of all descriptions, from the blank to the finished tool. Must be experienced in handling both male and female labour, able to fix rates, and capable of introducing the most up-to-date methods of production.—Write, stating full details of experience, also age and salary expected, to U. G. C., care of STREET'S, 30, Cornhill, E.C. 3. H 579

Works Engineer Required

for a large Shipbuilding and Engineering Works. Must be a thoroughly experienced man and capable of taking complete control as regards the maintenance and upkeep of the Works Plant Power Station, Hydraulic and Pneumatic Services, Cranes, &c.—Address, stating age, previous experience and salary required, to H 626, Offices of ENGINEERING.

Rate Fixer Wanted, for Engine

works. Accustomed to modern machine methods for medium and heavy classes of work. Apply with full particulars as to experience and wages expected. Good opening for experienced man. No one already on Government work need apply.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning No. A 3567. H 578

Electrical Power Engineer,

with experience in A.C. and D.C. motor factory equipments, preferably with drawing-office or test experience, for large manufacturing firm (Controlled).—Apply, stating experience, age and salary required, to your nearest EMPLOYMENT EXCHANGE and quote No. A 3537. No person already engaged on Government work need apply. H 571

First-class Experienced

ESTIMATOR WANTED by Government controlled works making large and small engines, repetition and general work; man with thorough practical knowledge of machining, fitting and foundries, &c., who could organize and control a department dealing with rate fixing, progress and demonstration. Only men thoroughly experienced need apply. Permanent position to suitable man. State age, experience and salary required. No one already employed on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 29.

Wanted, the Services of a

highly trained technical ENGINEER, for a short period, for the purpose of compiling a technical catalogue illustrating the manufactures produced by a very large firm, and containing useful information for Engineers, Architects, Builders, &c. Liberal terms to suitable man.—Address, H 609, Offices of ENGINEERING.

Manager Wanted, to Organise

and afterwards superintend ball bearing factory.—Address in confidence, giving age, experience and salary required, H 631, Offices of ENGINEERING.

Works Chemist.—Reliable

ASSISTANT REQUIRED in Laboratory of large Controlled Engineering Firm, Manchester district, accustomed to engineering and metallurgical analysis. No person already on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, stating age, experience and salary required, quoting No. A 3526. H 616

Representative Wanted, with

connection among shipbuilders, engineers, motor and aeroplane manufacturers, to obtain orders for non-ferrous castings, ingots, strip metal, billet brass, &c. A good man with first-class connection will be liberally dealt with.—Apply, Messrs. E. A. J. HOOPER, LTD., 21-31, New Summer Street, Birmingham. H 613

Correspondence. — English

CORRESPONDENT REQUIRED by a controlled firm near London, manufacturing well known engineering speciality. Must have good style and be possessed of sound engineering knowledge. No one on Government work will be engaged except with the consent of present employers.—Apply, with full particulars to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 549.

Accountant Required, by an

old-established company for works in Liverpool. State experience and salary required. Also ASSISTANT to Accountant.—Apply, BOX 2707, WILLINGS, Moorgate Arcade, London, E.C. 2. H 609

Works Accountant Required

for a large Motor Vehicle Works employed solely upon Government work; must have had good experience in the organisation and running of an up-to-date Cost Department. No one at present engaged upon Government work can be employed.—Apply, giving particulars of experience and salary expected, to H 657, Offices of ENGINEERING.

Metallurgist as Assistant to

head of hardening department in large manufacturing works. Experience of case hardening small parts essential. No one on Government work will be engaged without consent of present employer.—Apply with fullest particulars to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 654.

Engineers' Buyer Wanted;

preference given to one having experience in Locomotive and Light Railway work, also Estimating (he would be required to deal with all shop orders and materials). Only competent, experienced men need apply, and no person already on Government work will be engaged.—State experience, age and salary required to your nearest EMPLOYMENT EXCHANGE, quoting No. A 3459. H 643

Research Physicist Wanted,

for large scientific instrument factory. Graduate in science with workshop experience preferred.—Address, stating age, salary, and full details of experience, H 524, Offices of ENGINEERING.

Wanted, Confidential Clerk

for Manager's Office, large engineering firm in Manchester district. Good stenographer, accustomed to engineering terms. Up-to-date office arrangements, &c. No person already on Government work will be engaged. State age, full details of experience and salary required.—Apply, your nearest EMPLOYMENT EXCHANGE, quoting No. A 3566. H 653

Jig and Gauge Inspector

WANTED, at controlled factory in the Midlands. Only first-class men and those not already engaged on Government work will be considered.—Apply at your nearest EMPLOYMENT EXCHANGE, quoting reference No. A 3583. H 516

Jig and Tool Draughtsman

REQUIRED by small tool department of Government controlled establishment. Applicants should have had shop training and some drawing office experience, preferably in design of labour-saving tools. Permanent position and good prospects to suitable man.—State age, experience, salary required and when at liberty, and apply in first instance to your nearest EMPLOYMENT EXCHANGE quoting No. A 3505. No person already on Government work will be engaged. H 644

Wanted, First Class Jig and

TOOL DESIGNERS for small and accurate repetition work. Good salary to first-class men. No person resident more than ten miles away or already engaged on Government work need apply.—Address, by letter, BOX 173, care of MITCHELL'S Advertising Agency, 1, Snow Hill, E.C. 1. H 600

Mechanical Draughtsman

REQUIRED with general experience and good knowledge of French, by Westminster firm of Engineers. Good salary for suitable man. No one resident more than ten miles away or already employed on Government work need apply.—Address, H 622, Offices of ENGINEERING.

Several Mechanical Draughtsmen,

with experience in Deck Machinery and Ship Engineering and Fittings, REQUIRED for Admiralty work; commencing salary according to experience. No one already on Government work will be engaged.—Apply, stating age, experience and present salary, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and H 632.

Draughtsman (Mechanical),

one used to Jig and Toolwork preferred, WANTED by Midland firm manufacturing ball and roller bearings for aircraft and mechanical transport. Good salary according to experience. No man already on Government work can be engaged.—Application in the first instance should be made to your nearest EMPLOYMENT EXCHANGE, mentioning this Paper and No. A 3390. H 311

Draughtsmen, Senior and

JUNIOR, with experience in aeroplane internal combustion engine, motor car or jig design preferred.—Apply, stating age and particulars and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 3566. No person already on Government work will be engaged. H 569

Draughtsmen Required, for

service in an Admiralty Department, preferably with experience of marine engineering.—Applicants to state age, salary required, and details of previous experience (by letter only) to BOX No. 1192, care of Messrs. R. F. WHITE & SON, Genl. Advng. Agents, 33, Fleet Street, E.C. 4. H 564

THE RESTRICTION OF OUR COAL EXPORTS AND ITS EFFECT UPON THE GAS INDUSTRIES OF THE WORLD.

By George Frederick Zimmer, A.M.Inst.C.E.

Although we may all be justly proud of our coal industry, we can perhaps best realise its importance if we review the disastrous results caused by the restriction or cessation of our coal supplies to other nations. We learn, for example, from the *Revista Minera, Metallurgica y de Ingenieria*, of December 24, 1916, that, owing to the scarcity of coal, which commodity in normal times used to be supplied almost exclusively from this country (the year prior to the outbreak of war we exported 6,893,000 tons), South American gas works are now compelled to carbonise a mixture of coal and wood to maintain a supply of gas. It may not be out of place to remind our readers here that the use of this raw material is by no means an innovation, especially in countries rich in woods and forests, such, for instance, as obtained formerly in parts of Australia, where gas used to be produced from such a mixture with good results. Gas was also frequently so produced in the middle of last century in well-wooded districts on the continent of Europe, and particularly in Switzerland; a few belated installations survived even to the latter end of last century. About the year 1860 the towns of Bâle, St. Gaul, Zurich, Schaffhausen, Aarau and Lucerne, in Switzerland, were all lit by wood gas. Macon, in France, and many other continental towns, including Coburg, Wurtzburg, Darmstadt and Ulm, were at that time lit by such gas, and even part of Philadelphia. In Russia and other parts where coal is dear and wood cheap the latter is still carbonised in small out-of-the-way gas works.

The *modus operandi* for obtaining wood gas is somewhat different from that employed to obtain coal gas. For instance, the retorts are only about half-filled with wood, and they are heated to a greater degree, which causes the development of heavy hydrocarbon gases which, when purified, will give a brilliant light. The gas from wood, unlike that from coal, contains no sulphuretted hydrogen, but contains instead large quantities of carbonic acid, as well as some vapour of wood vinegar, from which it must be freed by treatment with lime. This treatment will eliminate both effectually, and the latter at any rate so that the apparatus, pipes and gas meters are not injured in the least by it. The composition of the wood gas necessarily varies with the nature of the wood from which it is produced, the method of distillation employed, the temperature of the retorts, whether the wood is wet or dry and whether or not it is resinous. The average constituents of wood gas are, approximately:—

2 per cent. of carbonic acid, CO_2,
35 to 40 per cent of carbonic oxide, CO,
30 to 35 per cent. of hydrogen, H,
10 to 18 per cent. of carburetted hydrogen, CH (methane).

Wood, whether from coniferous or from foliaceous trees, carbonises much more quickly in the retort than coal. The liquids produced by the decomposition contain much water, some wood spirit and acetic acid, no ammonia, and little tar. Dried peat and lignite may also be used similarly to wood, and with like results; as much as 11,830 cub. ft. of gas have been produced in Australia from 1 ton of timber; it might be taken as an average that 10,590 cub. ft. of gas can be produced per ton of wood.

We thus see that wood gas differs but little from the more modern coal gas, while, however, the specific gravity of the former is considerably higher, *i.e.*, 0.7, and it is the higher specific gravity of this gas which requires special consideration in the choice of suitable burners. An admixture of 10 per cent. of wood gas to coal gas will not cause any noticeable difference in this respect; with a larger percentage, however, Bunsen burners for incandescent lights, gas stoves, and gas rings, all show a tendency for the flame to strike back and ignite the unmixed gas, and to prevent this a special regulation of the air supply to the burner is necessary with this heavier gas.

In their present dilemma the South American gas works employ a mixture of equal parts of wood and coal, with, however, but indifferent results. The inherent difficulty in this process appears to be the judicious choice of woods; those of a specifically light nature, such, for instance, as willow and sallow, are deemed most suitable. The wood used in the case of South American gas works—evidently none too suitable—contains a considerable proportion of moisture, and can be obtained and delivered at the gas works at about 38 francs per ton. The timber is cut into small pieces before being charged into the retorts, and the charcoal which remains (about 25 per cent. of the weight of the wood charged) is a by-product of excellent quality. The yield of gas per ton is, however, only about 7,600 cub. ft.

Another difficulty is that, as already mentioned, owing to the high price of coal and freight the former is often not obtainable. The distillation of crude oil has, therefore, been resorted to. In this case both wood and oil are carbonised in separate retorts, and it has been found that the best results can be obtained when for every retort charged with wood three are charged with oil. Those for the latter purpose are charged with coke before the oil is introduced in order to give the greatest possible surface for the contact with the oil fumes. The retorts must be heated to bright red, and kept at a pressure of from 10 mm. to 15 mm. of water column.

The South Barracas gas works, being unable to procure English coal, were compelled to import coal from the United States, and the freight paid is said to have been 85*s.* per ton. They therefore resorted to a hard Argentine wood, which, when carbonised, yielded a gas which was mixed with the coal gas in order to make it go further. Argentine oil is also used to produce a kind of carburetted water gas for the same purpose. The most important of the English gas works undertakings in the Argentine, the "Primitiva," uses at present 7,000 tons of wood per month for gas production.

France, who in the year before the war procured from us 12,775,900 tons of coal, is no better off. The towns of Brionne (Eure), Marseilles, Viroflay, Chesnoy and St-Cyr have entirely ceased to light their street lamps at night for want of gas, while at Bordeaux 4,500 street lamps remain unlit, so that instead of the former 7,500 there are now only 3,000 alight at night; furthermore, gas is only supplied to consumers between the hours of 5 and 11 p.m. The gas works of Coulommiers have had to completely suspend gas production, while the Swiss gas works at Pontarlier have also been closed, owing to their inability to obtain coal from England *via* France. This all points to the serious want of coal for the gas works, and it is even contemplated to reduce the coal supply to the gas and electricity undertakings to one-third of the pre-war supplies. At a recent meeting of the Société Technique de Gaz the use of substitutes for coal was discussed, and it was decided to distil peat experimentally, for which purpose 6 tons of this material was conveyed from the Somme district. The necessity of shutting down some of the gas works owing to the shortage of coal, and the necessary safeguards during the interval of suspension, were also discussed.

A short while ago a Paris suburban gas works had only two days' supply in hand, and a Paris works only eight days' supply, while the electricity undertakings were similarly placed. The public, who have been repeatedly warned to economise in the use of gas and electricity are, however, now informed that the worst of the coal crisis is past, to their great relief. The turning-point was reached as a result of a recall of a number of skilled miners from the Front, and by their patriotic agreement to work an extra hour per day. In addition to this a further supply from this country has helped to meet the most urgent needs.

Our Italian Allies, who have no indigenous coal, and who in the year before the outbreak of hostilities, imported from Great Britain 9,647,000 tons of coal, are in the same plight. There has been a latent coal crisis in Italy ever since her war with Turkey in 1913, as during that period the agents cancelled their contracts, ostensibly for political reasons, but in reality probably in order to get higher prices. In consequence of this and other troubles, including the strikes during that period in the English coalfields, the coal stocks of Italy were low at the outbreak of the present war, and whereas the price of coal before the war ranged from 25 lire to 35 lire per ton delivered at the gas works (the price varying with the geographical position of the gas works) by the end of July, 1914, it had risen to 50 to 60 lire, and after the outbreak of the war it rose to 100 lire and over. When Italy joined the Allies and declared war against Austria-Hungary the price of coal rose from 200 lire to 220 lire per ton, and has never been less since, but rather inclined to rise still higher.

Italy possesses about 200 gas works, 38 of which are municipal property; the rest are private undertakings principally capitalised by England and France. Concerning the municipal gas works, those of the following towns have been closed: Ascoli-Piceno, Caltanisetta, Imola, Rovigo, Piove di Sacco, Canegliano-Veneto, Brà, and others. The privately owned undertakings are held, as far as possible, to the fulfilment of their contracts with the municipal authorities, and are therefore in a most precarious condition, and since some of them stopped manufacture the municipalities continue to run the gas works under their own management, and are debiting the owners with the cost. Some of these are the gas works of Aneglia, Porto-Maurizio, Catanzaro, Aversa, Caserta and Taranto. Some of the towns have doubled and trebled the price of gas. The street lighting throughout Italy has been reduced by half, and the lamps are extinguished at midnight.

It appears extraordinary that the price of coke in Italy has not risen in proportion to that of coal, but at the middle of 1916 coke was costing only about two to two and a half times as much as before the war, while coal cost about seven times as much. All gas works are running at enormous losses, as in most cases the authorities will not sanction the increase in price of gas, and where it is permitted the price cannot be raised to even cost price on account of the cheap competitive electric supplies, the prices being low even now, because the electric works are mostly driven by the abundant water power available.

The Italian gas engineers are compelled to employ substitutes for coal. The gas works of Perugia, for instance, are now carbonising lignite, which is found in the vicinity. Experiments were likewise made with the carbonisation of oak, in the proportion of four parts of coal to one of wood, and as the process developed further wood only was used, at any rate since May, 1916. The oak is carbonised from two to three hours, and in order to save labour the retorts are here charged with logs 12 in. to 20 in. long. The lighting and heating value of this wood-gas appears to be about the same as that of coal gas, the same quantity being consumed now as formerly when coal was used. The proportion of charcoal taken from the retorts is 25 per cent. of the original weight of the wood.

It may be mentioned that lignite from Sardinia had been experimented with at the gas works in Rome in the early part of 1914, so that any experience gained then may now be of considerable value to them. The gas works in Rome work at a deficit of 450,000 lire a month, incurred by the enhanced price of coal, the price of gas presumably not having been much altered.

In Holland the same difficulty is felt, so that at Haarlem the gas consumption has had to be reduced by half; in further evidence of the shortness of coal it might be mentioned that the electric tram-cars there are now no longer running.

Germany, which in the year before the war imported 8,952,000 tons of English coal, and which has now to make up this deficiency, does not appear so much to be short of coal, as to lack means for distributing it, owing to the need of rolling-stock. Whatever the reason for shortness of coal in the enemy country may be, there can be no doubt that coal is short at the gas works. On December 11, 1916, the authorities restricted the use of gas considerably. It is not allowed to be used for lighting the shop windows from outside, or for any advertising purposes, and altogether its use is restricted to an absolute minimum. The lighting of the streets must only be sufficient to ensure the safety of the public traffic. Another significant indication of the shortness of coal is given by the fact that all gas works in Germany were officially requested in November last to give the tonnage of

their coal stocks, and were, furthermore, urged to economise in carbonising for a large yield, which, of course, is tantamount to the reduction of the gas in heating value, which incidentally affects the adjustment of the incandescent burners. This has made it necessary to instruct the general public in the way in which these adjustments should be made, as no gas fitters are available for the purpose. (Gas of a lower heating value must have a lesser amount of air mixed with it to prevent the flame striking back.) In consequence of inferior German coal being used the yield of the retorts has been lessened, and whereas in 1914 12,714 cub. ft. were produced per retort, the output fell in 1915 to 11,901 cub. ft., and in 1916 to 11,054 cub. ft.

Owing to the extended area now covered by German activity the shortage of railway wagons and locomotives has hampered the distribution of coal, in consequence of which the stocks of some of the gas works have run short, particularly in districts close to the war zone. The effect of this shortage was felt considerably, and as much as 50 per cent. of water gas had to be added as the coal became scarce; for instance, in 1914 in Eastern Prussia, in 1915 in Poland, and in 1916 in Transylvania.

In Dusseldorf the debenzolised gas recently supplied had a calorific power of only 508 British thermal units, compared with the normal 545 British thermal units per cubic foot; more recently the gas was diluted by the addition of 16 per cent. of simple water gas to the debenzolised coal gas, with the natural consequence of lowering the already low calorific power to from 482 to 493 British thermal units, and at times even to 476 British thermal units, per cubic foot. Altogether as much as 50 per cent. of water gas has been added to the coal gas, and this causes rusting in the iron pipes and pendants in the house services and subsequent blockages. As a result of paraffin also being scarce an extra demand has recently been created for gas, and the number of prepayment consumers has increased in the last two years by 18 per cent. This is explained as follows: In the second half of 1914 and the first half of 1915 a considerable falling-off in gas consumption was noticed, owing to the breaking-up of homes and suspension of works and other establishments. Since the war pressure has been felt a considerable number of people who used, formerly, to light their homes with paraffin have been compelled to use gas, so that the consumption of this commodity has gradually but constantly risen. The price of gas in Berlin has, however, remained unaltered.

Many other practices are in use in the enemy country for "stretching the gas," one being the addition of blue-water gas up to one-third of the mixture, or by putting in a smaller proportion of flue gases or producer gas. The motto of the German gas engineers appears now to be "Little gas is better than none, and gas of low calorific power is better than a short supply."

At Cronstadt, in Hungary, it was decided in October last that consumers who chose to use more than half the quantity used formerly for lighting purposes should pay 47*s.* per 1,000 cub. ft. for all gas consumed in excess of this and for heating purposes the same amount for all gas used in excess of two-thirds of the former consumption—the most effectual way, no doubt, to guard against waste. A significant sign of the times was the shutting down, on the night of January 3 last, of the gas works at Ludwigshafen, on account of the shortness of coal and also of skilled labour.

In Norway the Municipal Supply Council at Christiania have recently (according to Reuter's Agency) decided to requisition the stocks of coal and coke, as well as other fuel in the gas works, and distribute them, together with the stocks likewise commandeered from private sources. It goes without saying that our own gas works have also to suffer in various ways, besides which the coal has been increased in price by 50 per cent. and the freight by 400 per cent.

INDUSTRIAL COUNCILS AND THE GARTON MEMORANDUM.—No. III.

The purpose of these articles is to examine the Industrial Councils proposals in what may with reasonable probability be called their original form, with the benefit of the able and comprehensive argument in which they were set forth. The summary given in the two previous articles, though it does not at all reproduce the elegance of the Memorandum and its literary art, describes the argument fairly. If it has succeeded in fulfilling its intention it has also illustrated the plausibility and almost ostentatious impartiality of the original; and it may only be on a second reading that these qualities will be seen to be less real than they appeared at first. The Memorandum is developed on data stated by the authors almost as axiomatic, from which they derive certain formulæ for the needs of practice; and the argument returns always on these formulæ as the ultimate foundation of the measures proposed. The accuracy of these statements, the soundness of the reasoning, and the impartiality of the exposition are essential to the authority that is claimed for the proposals; and this claim is now the more considerable because of the adoption of essential parts of the authors' scheme in the proposals that are before the country. A closer attention to the argument that is now suggested will show that some of the fundamental data are contradicted by fact, that in parts the argument has been "cooked" to suit the conclusions to which it is intended to lead, and that the professed impartiality is merely formal. Some examples may be examined briefly before discussing the details of the Councils proposals, both to get a better measure of the authors' authority than is given either by the credentials that they invoke or the skill with which they write, and to clear up some important facts that they have misstated or obscured.

The Memorandum opens with a formidable threat of impending anarchy, stated first as merely industrial, but insinuated later as perhaps revolutionary and bearing the seeds of 1789 and the Terror. That industrial unrest exists, however caused and by whomsoever fomented, has long been common ground, and so has the conviction that the interests of all parties to industry and of the whole nation demand that the old attitude both of employers and employed to their common enterprise must be profoundly modified. The need that the changes should be made as thoroughly and as quickly as possible cannot be too strongly proclaimed. But the demand for reform is not strengthened but weakened if the claim is sought to be enforced on unreal grounds, as has been done in this bogey of revolution. The grossness of the threat exposes its insincerity. Revolutionaries exist in most societies, but the possibility of their success depends on the conditions of society and government. It is not worth spending time to discuss whether the present conditions of British society and the resources of the Government through which it maintains itself can be compared with those of France at the date of the Revolution, or are unequal to the abortion of the utmost revolutionary influence that may be concealed behind the threat.

But beyond the misstatement of the position in the general community the authors add an equally imaginative inference to a particular class. They allege that many of those who have already come back from the front are among the most active in their discontent. What the views of the men at the front are will be seen when the great body of them do come back. In the meantime the answer to the allegation is plain. The men who have come back and are in industry can only be a trivial part of the whole army, and the grounds of their discontent are not stated. If they have really grasped the situation, they have reason enough for complaint; not, indeed, in their own conditions of work, which on the whole are notoriously better for the time being than they were before the war, but in the manner in which the needs of the fighting forces have been and still are being subordinated to political influences. If this is the ground of complaint, it would lead the men away from the influences that procure such an abomination. But if these men have not grasped the situation, which has been sufficiently exposed in recent numbers of this journal to make its present reiteration unnecessary, or if, having grasped it, they are blind to its causes or insensible to its inhumanity and treachery, the suggestion that such men represent fairly the temper of the Army and the Navy of whom they are a minute fraction is an unsupported libel on the intelligence, fellow-feeling and good faith of the fighting services.

Among the suggested causes of the discontent imputed to Labour, much stress is laid on the privileges of the trade unions and the difficulty in restoring the *status quo*. The workmen—by which term the authors mean the trade unionists, who, according to the Memorandum, constitute only a fourth part of industrial society, or, more correctly, of the tiny fraction of that fourth part which forms the real power of the unions—are said to have foregone for the purposes of the war their most cherished safeguards, and to fear that the agreement for their restoration will not be performed. Here, again, the actual facts have been stated so recently that readers of this journal do not need that the discussion should be repeated. They know that though the privileges in question were promised to be wholly foregone, they have been and are being in part maintained as the constant safeguard of the German forces. They know that the *status quo* and the guarantee given by Parliament, restoring liberty alike to the three-fourths of workmen who were not unionists and the one-fourth who are, could be reinstated and fulfilled if it were desired; that what those who clamour for this restoration fear is that it would not be enough for their purposes; and that what would prevent the *status quo*, if it were restored, from remaining permanent is the operation of forces other and higher than those of Parliament, Capital, or Labour. But apart from the insincerity shown in the assertion of these claims by those who know their true worthlessness, they are founded on the assumption that the privileges which had been tolerated in peace would, or should, have been allowed as rights in war. And this assumption is as revolting to common-sense as it is to humanity and good faith. The men who gave themselves or have been taken body and soul for the service of the armies, the creditors who, very wisely, were forbidden to recover their debts, might well think that neither trade unions nor any other bodies or individuals could retain rights during the war by which its agonies might be prolonged for a single day or a single one of their lives be sacrificed; and in particular these men might have felt sure that if for any benefit to themselves a small fraction of the community had asserted a right to restrict the output of munitions or the maintenance of essential industries, so execrable a right would have been suspended instantly without asking or permitting the assent of those who had the effrontery to claim it. To such extent as trade-union privileges could have such consequences—and to no other extent are they in question—they ceased during the war to be a legitimate right of the unions; and only doctrine such as is expounded in the Memorandum could have led any considerable body of British working men to permit claims to be made on their behalf for their maintenance while the lives of soldiers and the safety of the country demanded that they should be abolished.

A similar perversion of facts appears in the somewhat meagre account of "scientific management," that excellent method with the unfortunate name. The Memorandum describes it as shutting the workman out from higher grades of employment, and forcing methods on him that are imposed by experts other than the masters of his own craft. The contrary of the truth could hardly be expressed with greater precision. So far from shutting workmen out from any sort of employment, scientific management is concerned above all things to put each man, in whatever employment it may find him, on to the work in which he can best pull his weight; and a chief obstacle to men's having such opportunities in this country is the practice of the trade union itself, which forbids their services to be so used, and tries to tie each man down to one narrowly defined class of job. So far, again, from the method's operating to shut men out from the higher grades of employment, an essential part of its mechanism consists in multiplying manifold the number of directional posts to which workmen can be promoted. Its manufacturing operations, again, can be prescribed efficiently only by men with a peculiarly

intimate knowledge of the work; and Taylor himself was originally a workman, and invented and began to practise the methods of scientific management while he was working up through the various lower grades of employment.

Reference has been made to the impartiality that is affected throughout the Memorandum. Considerations on the side of Labour are balanced with elaborate symmetry against others representing the case of Capital, and the reader by implication is invited to infer that each set has about the same intrinsic importance. But if the two groups of considerations are compared it will be seen that, except those relating to unemployment and to wages, they are quite different in quality. With these two exceptions, which the authors state repeatedly are less important to Labour than the others, the men's grievances are confined to their way of life, but the employer's extend to the means by which they and he live. The workman is said to feel that, putting it bluntly, he is not made of sufficient consequence in the business; a perfectly proper subject for discussion, but one which, even if the complaint be justified, is of a quite different order of magnitude to that of complaints against practices which tamper with the bread and butter of the men themselves and everybody else.

The impartiality that sets such matters off against each other is merely ceremonial; and the balance is weighted even more grossly in the authors' postulates of equal knowledge and equal responsibility for both parties to industry. Each of these postulates is impossible. The description quoted in the summary of the knowledge that is required in management, though incomplete, is sufficient to show that men engaged in manual work can by no exertions of their own or teaching of others learn as much as their employers of the various aspects of business management, all of which at one time or other have an essential bearing on workshop direction. A man in mechanical employment who was able to pick up even a fraction of it would under any competent management find himself in a directional post instead of the less productive occupation of actual manufacture. Against the workmen's imperfect knowledge of technical and business matters, an ignorance which almost always is the necessary consequence of his occupation and no hindrance whatever to his doing his own job completely, the authors impute to the employer a corresponding ignorance of his men's social and material needs and aspirations. But such ignorance, where it exists, is a result not of the employer's occupation but of his incompetence. To know how his men live, what they need and desire, is an essential part of the employer's business; and if he is not himself a graduated workman, as in some trades he mostly is, he has those on his staff who are, through whom he can find out.

The claim for equal responsibility is no less fantastic. Although both employer and employed are responsible for what they do in the common enterprise, the workman has no responsibility corresponding either to the employer's provision of capital or to the risk he runs of losing it. The claim is obviously made because it is necessary to the hypothesis that Capital and Labour are bound by a technical partnership and not merely by their co-operation in a common enterprise; for nothing short of such a partnership could justify their proposed measures.

The somewhat laboured treatment of this question of partnership illustrates not only mistakes of fact but also the authors' practice of inventing explanatory premises to suit preconceived conclusions. For some unexplained reason they assume, for instance, if the three functions of providing labour, management and capital into which they divide industry happen to overlap, and more than one function may sometimes be performed by the same person, a partnership is created between those who discharge these several functions, even when they are separate persons; and to bring all industry within this assumption they represent Capital as the result of past services rendered by Labour and Management as well as by itself. The assumption is foggy, and difficult either to understand or admit; but the description of Capital is simply incorrect. What the joint services of the three parties produced was not capital but income, which was distributed for their separate uses; and it became capital not by the help of Management or Labour, but through the unaided foresight or self-denial of the capitalist himself.

Even in commending their proposals to workmen the authors show the same reluctance to put up with plain facts if some plausible but inaccurate explanation seems to offer a more attractive prospect. In discussing, for instance, the worker's belief that the more he does, the less will be left for himself and others to earn, they explain that his fallacy is that of the "fixed wages-fund," which, as they say truly, ignores the necessary increase of aggregate wages as the volume of production increases, but this is no answer to the men's doubt, which is based on the assumption that the increased product may not find a market and so may lead to dismissals. The real answer is, of course, that the difficulty the men suspect may occur, but that to decrease production and so increase cost would be a remedy worse than the disease, for, through forces of international competition, it might deprive the men even of the work with which they started. The admission and the threat would doubtless be unpalatable; but, being true, they should have been expressed.

No useful purpose would be served by underlining instances of mere prejudice, though the mention of them is necessary to complete the picture. An objection to an employer's retaining a larger share of the gross gain from scientific management than is given to the men is presented as "natural soreness," though the authors know that the method merely enables men to do better for their employers without greater fatigue to themselves, and that out of his share of the gain the employer has to pay the heavy cost of setting up and administering the system. It is in the office that they find the "deadheads" who impair the efficiency of management, not in the shop stewards, who are paid to work on production, but are allowed to spend their time on enforcing restrictions on output. They are alive to the short-sighted practice of cutting piecework rates when men earn much more than their standard money, but have nothing to say of the men's disposition to claim the rates given to the most industrious and competent men as the proper minimum for men who are neither. They see the interest and disposition of the workman to maintain the standard of quality a good deal more clearly than it is sometimes to be seen in the shops; but to the employer, whose capital is safeguarded by the improvement in goodwill, they think quality to be likely to be a secondary consideration. They condemn the disposition of some employers to tyrannise over their men, though they admit quite fairly that it is probably exceptional; but they have no word of reproof for the tyranny that is exercised over men by trade unions, which is not exceptional but habitual and continuous.

It is needless to multiply such examples; but before passing to examine the Councils scheme it is desirable to remark that even the implied profession that the authors are in part the advocates of labour is itself a pretence, disclosed unmistakably in its own proposals. They are not the advocates of the rights of Labour, but of the claims of those who seek to dominate it; and they find themselves able to assert even the barest and most obvious needs of workmen only so long as they think Labour strong enough to be independent of their advocacy.

They profess, for example, to be penetrated above all things by a sense of its poverty and helplessness, and they propose that a minimum wage shall be fixed in the trades in which the workers cannot obtain fair conditions for themselves. Yet they stipulate that this relief is to be given only to those trades in which it will not raise the price against the consumer; in other words, that where the consumer is already enjoying an advantage from the unfair conditions of work that they profess to attack, the reform is not to be adopted if it will prejudice the equally unfair profit to the consumer. The sincerity of their professions is, indeed, well illustrated by this instance, in which they propose to sacrifice the most needy of their clients in order to propitiate the source of the power that they seek. To avoid misapprehension it may be pointed out that the odium of this conduct does not depend on its being due to a corrupt motive. Ambition, love of power, even the priggish belief that the working man cannot be properly served unless they have a finger in the pie, might be the motive of the conduct, and it would still remain equally unfair to workers and mischievous to industry.

The authors' willingness to sacrifice the interests of Labour is shown on a more wholesale scale in their proposed treatment of the National Debt. They recognise that repudiation would be both dishonourable and inexpedient; at the same time the discharge of the liability would be inconvenient and onerous. So they recommend that in the first place wage-earners should be encouraged to save, and to invest their savings in Government funds. By the simple device of then causing taxation to fall mainly on the creditor classes the lenders to the State will thus take over the inconvenient national liability, and will have themselves to find what is required for paying interest on their own loan and repaying to themselves their own capital. It is a new way to pay old debts, which would have done credit to Hadji Stavros himself, the bandit king of the Greek mountains; and it illustrates the authors' opinion of the intelligence of Labour and the crudeness of the devices by which they think that it can be deluded.

MAKING MACHINABLE CASTINGS FROM PERMANENT IRON MOULDS.

WHEN addressing the Philadelphia Foundrymen's Association last June, Mr. Alexander E. Outerbridge, jun., the metallurgist of Messrs. William Sellers and Co., Philadelphia, remarked that it would be a great surprise to the meeting to hear that machinable iron castings had been made from permanent iron moulds in the foundry of his firm ever since 1888. More than a hundred such iron moulds, varying in weight from a few pounds up to 7,000 lb., were to be found in use there. The statement will probably be a surprise to some of our readers as well, and Mr. Outerbridge's references to his practical experience will be of interest.

The main object of using iron moulds is to secure machinable castings of exceedingly fine grain, free from dirt, sponginess and other defects, and at the same time of superior strength. It is, on the other hand, very important to command some simple and inexpensive means of changing the properties of the molten iron after tapping it from the cupola. Otherwise soft iron would, in car-wheel foundries making a large variety of wheels of different sizes and classes, have to be melted in a separate cupola every day, such iron being required to mix in varying proportions with the regular iron in separate ladles in order to adapt it for the particular class of castings in hand.

Between 1880 and 1884 Mr. Outerbridge was engaged in carrying out many experiments on the possibility of altering the character of cast-iron in the ladles by treatment previous to pouring, by the addition of small quantities of aluminium and ferro-manganese, but although the results were in the right direction they were not quite satisfactory. Further researches, however, led to the addition, just prior to pouring, of powdered ferro-manganese alone in the proportion of 1 lb. of 80 per cent. ferro-manganese to 600 lb. of high chilling iron, with remarkable results, and in 1888, in the course of a lecture delivered at the Franklin Institute, he was able to announce that the transverse strength of iron so treated was increased by from 30 to 40 per cent., the shrinkage decreased by 20 or 30 per cent., and the depth of the chilled shell was reduced by about 25 per cent.

The first announcement of the fact that manganese, a hardening element in cast-iron, had a softening effect on the metal in the ladle met with incredulity. But as no patent was taken, the use of ferro-manganese soon spread, and indeed developed into an abuse. For ferro-manganese acts as a reoxidising and desulphurising flux only in low-silicon iron; but, Mr. Outerbridge emphasised, it is useless, if not positively harmful, when added to foundry mixtures carrying over 1 per cent. of silicon and but little combined carbon. It would be valuable to have Mr. Outerbridge's opinion on the

relative proportions of carbon, manganese, silicon, &c., desirable for different purposes, especially also with respect to the results alluded to in the following paragraph. Authorities do not agree as to these points; there has been little systematic research on cast-iron—as distinct from steel—and the foundry experience generally remains private. Our recent notices of such investigations concerned the work of Professor Wüst, at Aachen (see ENGINEERING, July 20, 1917, page 64), and of Mr. J. E. Johnson, jun. (see ENGINEERING, May 18, 1917, page 484).

The good services rendered by ferro-manganese induced Mr. Outerbridge to experiment on ferro-

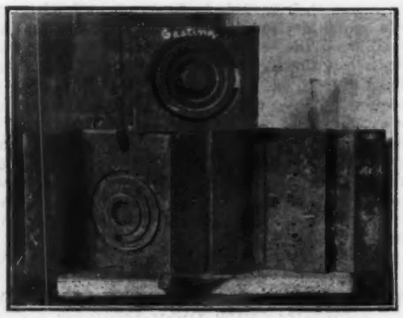


FIG. 1. IRON MOULD FOR SADDLE OF 36-IN. PLANING MACHINE.

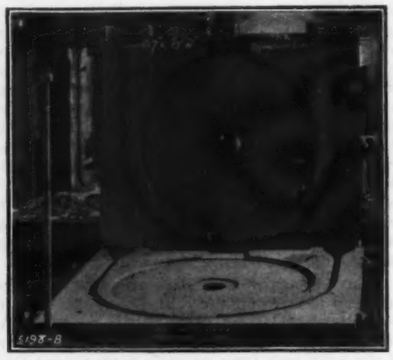


FIG. 2. IRON MOULD FOR FRICTION DISCS OF DYNAMOMETER FOR THE PENNSYLVANIA RAILROAD CO.

FIG. 3. IRON MOULD FOR GEAR RING OF 42-IN. CAR WHEEL LATHE.

silicon, and these experiments were later resumed when the electric furnace had placed a 50 per cent. ferro-silicon at the disposal of the steel maker. In his lecture delivered to the Philadelphia Foundrymen's Association Mr. Outerbridge tabulated the results of experiments he had conducted in 1905 on adding ¼ lb. of this ferro-silicon to 25 lb. of molten iron in a hand ladle, or 1 lb. of the ferro-silicon to 200 lb. of the iron. There were decided gains, ranging from 5 to 26 per cent. in the breaking strength, and up to 31 per cent. in the deflection, while the resilience rose to 67 per cent. maximum. The shrinkage seemed little affected by the addition, or showed a slight increase.

Mr. Outerbridge mentioned that though samples of treated iron, cast in sand, were all soft, they might differ considerably in chilling properties when low in silicon without displaying any differences in fracture; these properties varied much more than was generally known in similar grades melted in different days, or even in different portions of the same heat. His photographs of specimens demonstrated the remarkable reduction in the depth to which the chill penetrated when the iron treated with ferro-silicon was cast in an iron cup, as is done for testing purposes. The problem of making iron castings in iron moulds has engaged many metallurgists. Mr. Outerbridge referred in this connection to the recent notable work of Mr. Custer, who turned the castings out of the moulds before the molecules had taken a final set, so that the intense heat in the body of the casting helped to anneal any skin-chill formed. But Mr. Custer had failed to consider the fact that grey cast-iron, of which his moulds were made, grew in dimensions when repeatedly heated above a certain temperature and then cooled. This property, Mr. Outerbridge had been informed, had rapidly deteriorated Mr. Custer's casting machinery. As to this tendency to growing, Mr. Outerbridge exhibited two bars, first shown to the association in 1903. They had been cast in one mould from one ladle, both being originally of the dimensions $14\frac{1}{16}$ in. by 1 in. by 1 in.; the metal had had the density of 7.21, making 450 lb. to the cubic foot. One of the bars had been made to grow in the solid, and had now the dimensions $16\frac{1}{8}$ in. by $1\frac{1}{8}$ in. by $1\frac{1}{8}$ in., amounting to an increase in volume of 41 per cent.; the density of the expanded bar was 5.54, making 350 lb. to the cubic foot.

The warping or growing of the moulds could be prevented by two distinct methods, Mr. Outerbridge stated. The simplest method which they had adopted in Messrs. Sellers' foundry was to make but one casting from one melt in one iron mould. With this restricted use the mould never got hot and thus did not grow. The second method was to use low-silicion iron for the moulds, as a metal of that character grew far less when repeatedly heated above cherry red and subsequently cooled than soft foundry iron did. Finally, castings made of white iron do not, when heated and subsequently cooled, show permanent expansion sufficient to overcome the original shrinkage of the metal; when practicable, permanent iron moulds might hence be made of white iron.

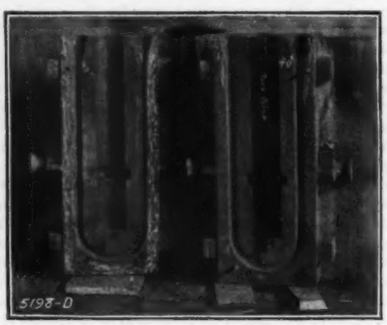


FIG. 4. IRON MOULD FOR SPINDLE OF HORIZONTAL DRILL.

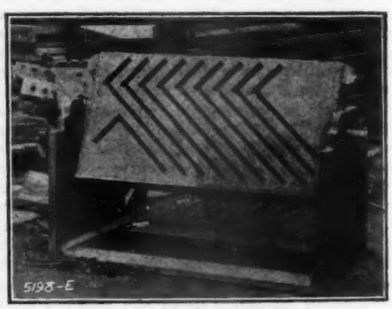
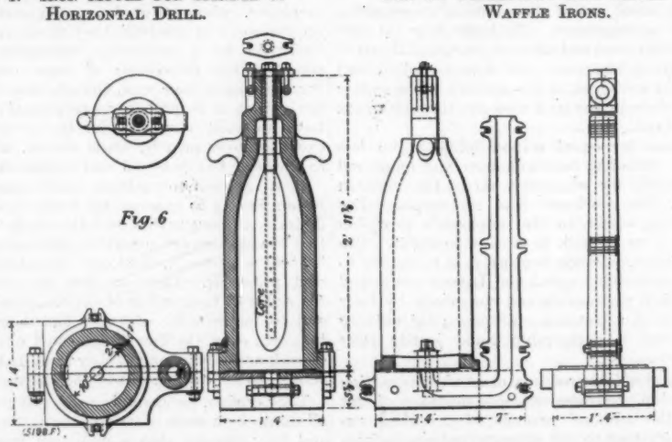


FIG. 5. PERMANENT IRON MOULD FOR WAFFLE IRONS.



As regards the relative cost of castings made in permanent iron moulds, or in green-sand moulds, or in baked sand moulds, the number of machinable castings required to be made from one pattern has, of course, to be taken into primary consideration. The use of any permanent moulds naturally means saving of skilled labour. In this respect the history of Mr. Outerbridge's iron moulds, photographs of some of which we are able to reproduce, was very instructive.

Fig. 1 shows an all-iron mould made in 1903 for a saddle of a 36-in. planing machine, as well as one of the grey machinable castings, absolutely free from skin-chill, made in this mould; it would have been difficult to avoid surface and draw-hole defects in this case with a sand casting; the iron mould gave perfect castings, and had been used for all the saddles until a new design was adopted. The moulds for the large dynamometer friction discs, 42 in. diameter, of the Pennsylvania Railroad (Fig. 2) have to supply castings of fine grain, finished on both sides and free from blemishes. This could not be done in sand moulds, but was easily attained in the iron moulds, pouring from the bottom. When cast these discs have a thickness of $1\frac{1}{4}$ in., finished all over a thickness of $\frac{7}{8}$ in.

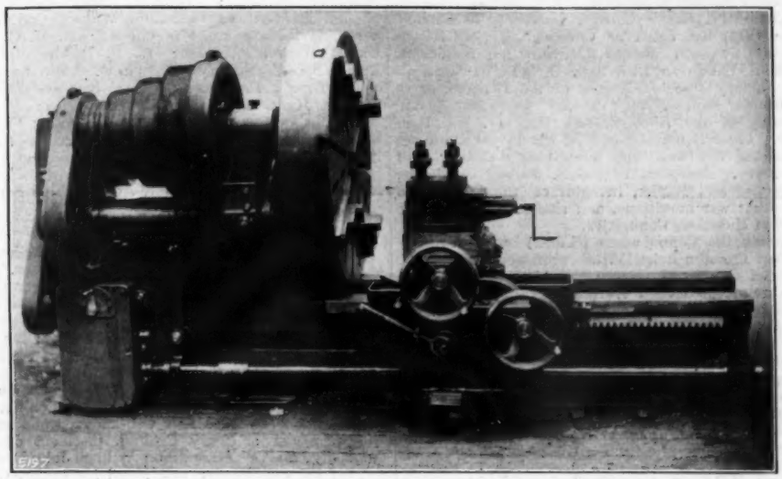
The photograph, Fig. 3, of an iron mould for a gear ring of a 42-in. car-wheel lathe shows the collapsible central portion. The mould is cast open; semi-steel (containing 25 per cent. of steel) is used and rendered non-chilling. Over 100 semi-steel gear rings have been cast in this mould. The blank ring, which has a diameter of 5 ft., a depth of 8 in., and a thickness of 6 in., is cast solid, and teeth are cut from the solid.

The iron mould for the spindle of a horizontal drill (Fig. 4) is also of considerable dimensions, 5 ft. long, $21\frac{1}{4}$ in. wide, 15 in. thick. The core is $2\frac{1}{2}$ in. in diameter, and the metal of the spindle has a thickness of $1\frac{1}{4}$ in. The casting is poured from the bottom.

The permanent mould, mounted on trunnions, for waffle irons (Fig. 5) has been in use since

TREBLE-GEARED BORING AND FACING LATHE.

CONSTRUCTED BY MESSRS. HAIGHS (OLDHAM), LIMITED, ENGINEERS, OLDHAM.



1890 for casting many thousands of gaggers. Finally, we reproduce in Fig. 6 the drawings for an iron mould designed for the United States Government in 1891 for casting 10-in. projectiles, 30 in. long. The grey iron shells made in this mould were machined all over and resembled steel projectiles in the fineness of grain and polish. The Washington authorities acknowledged at the time that the fourteen castings from this mould were the finest cast-iron projectiles ever delivered; but it was decided at that period that steel alone should be used for projectiles, so that the mould has not been put to any further service.

TREBLE-GEARED BORING AND FACING LATHE.

THE lathe illustrated on this page comprises a powerful headstock carrying a strong four-jaw independent chuck, mounted on deep box-pattern bed with self-acting compound slide rest. The headstock is treble-geared and carries a large four-speed cone. The hollow spindle is of good quality steel running in bronze bearings of large diameter and length. The spindle nose is screwed to receive the chuck or face-plate, and the thrust is taken on a ball bearing.

The compound slide rests have longitudinal and transverse self-acting motions and hand adjustments, and are so arranged that the two motions cannot be engaged together. A tray is cast on the saddle to protect the bed-ways from chips and water. A reversing motion is also provided. The self-acting feed has four changes operating through a gear box, and drop worm. All gears are machine cut from the solid and guarded.

The lathe, which is constructed by Messrs. Haighs (Oldham), Limited, Oldham, is supplied complete with four-jaw independent chuck, two-speed countershaft and spanners.

Will swing in diameter ...	3 ft. 6 in.
Will swing in front of chuck...	3 ft.
Width of bed face	2 ft. 2 in.
Cone diameters ...	21 in., 17½ in., 14 in., 10½ in.
Width of belt...	4½ in.
Gear ratio. Double gear ...	4 to 1
Gear ratio. Treble gear ...	24 to 1
Spindle speeds: r.p.m. ...	4½, 5½, 7, 8½, 10½, 13, 17, 21, 25, 31, 40, 50, 63, 78, 100, 125
Hole through spindle ...	3⅜ in.
Diameter and length of front neck...	6¼ in. by 9 in.
Diameter and length of back neck...	5½ in. by 7 in.
Countershaft speed, r.p.m. ...	200 and 250
Feeds, cuts per inch ...	5, 10, 20, 30
Floor space	11 ft. by 6 ft.
Approximate net weight ...	4½ tons
Approximate gross weight ...	5½ tons

THE SPELLERIZING PROCESS.—To overcome the tendency to corrosion in small iron and steel parts, says *The Railway Review*, Chicago, a process known as "spellerizing" has been evolved. This is technically defined as follows: "Spellerizing is a process of treating metal which consists in subjecting the heated bloom to the action of rolls having regularly-shaped projections on their working surfaces, then subjecting the bloom while still hot to the action of smooth-faced rolls, and repeating the operation, whereby the surface of the metal is worked so as to produce a uniformly dense texture, better adapted to resist corrosion, especially in the form of pitting." The aim of the process, adds the *Review*, is to make the metal uniform, so that corrosion will be uniform, and not in the form of pitting, since pitting indicates the presence of weak spots.

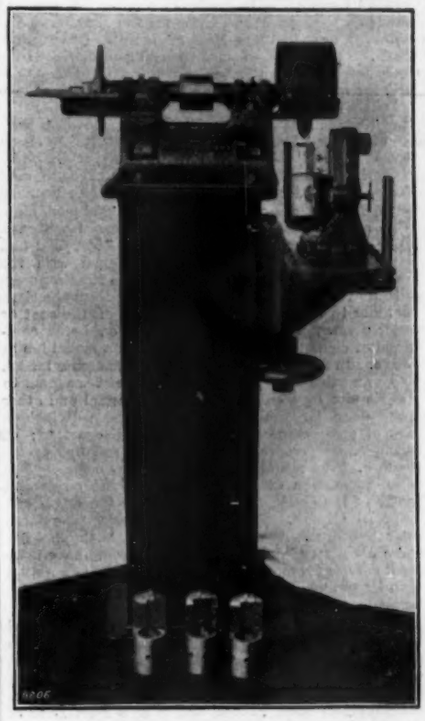
AMERICAN SHIPBUILDING.—Whilst the official figures showing merchant ship construction in the United States have not been made public since early in the present calendar year, there is reason to believe, says *The Iron Age*, that the total output of the American yards, including work done for the United States Shipping Board, will amount to nearly 1,500,000 tons by December 31 next. It is therefore apparent that the merchant shipbuilding of England and the United States together has exceeded the losses inflicted by the submarine campaign, this calculation taking no account of the superior efficiency of the new vessels built as compared with those destroyed.

AMERICAN RAILWAY IN FRANCE.—We read in *The Iron Age* that one of the chief events in the American steel market in the commencement of the present month, August, has been the buying of 150,000 tons of rails by the American Government for the building of a double-track railway from its French port to its battle front. The Washington Government's railway operations in France will be on a large scale, and a vast engineering programme is included. There will also be considerable buying of light rails for portable tracks. The standard sections just bought are 80-lb. rails. Either Bessemer or open-hearth rails will be accepted, 38 dols. per gross ton being paid for the former and 40 dols. for the latter. The Steel Corporation took 90,000 tons of the rails, and the remainder was divided between three companies. Over against the above prices for rails, which are those at which railroads bought last year for late 1917 delivery, are current sales at 100 per cent. higher. At Chicago a 700-ton sale of rails has just been made at 85 dols. For the Government's French railway 300 locomotives have been placed, and there are negotiations for 17,000 cars.

BLACK SULPHUR.—Various modifications of sulphur are distinguished, and long before allotropic modifications were suggested to explain peculiarities which are more simply explained probably by the presence of impurities, certain black, blue, green and red sulphurs were described as modifications of the element. Black sulphur was supposed to be formed when yellow sulphur was repeatedly heated above 300 deg. C. and suddenly cooled. Knapp stood up for this black sulphur of Magnus in 1888, whilst himself pointing out the difficulty of avoiding impurities in such experiments, and it should be noted that the existence of a grey and a violet phosphorus has been confirmed by the recent high-pressure experiments of Bridgman, Smits and others. The natural black sulphur from Mexico is simply impure with carbon or some metallic sulphide, however, according to B. Neumann (*Zeitschrift für Angewandte Chemie*, June 26, 1917). He found up to 0.77 per cent. of carbon in some large specimens of black sulphur sent to him, and traces of iron sulphide and other sulphides in others. All these sulphurs occur in gypsum under conditions which make a contamination by decomposed hydrocarbons possible.

NAIL DIE GRINDING MACHINE.

FOR grinding the dies of wire nail machinery, Messrs. Sleeper and Hartley, Inc., of Worcester, Mass., U.S.A., have brought out the machine shown in the annexed illustration. It comprises a spindle with a grinding wheel mounted on each end. One is for squaring the dies, and guides are provided on the work rest to facilitate the operation. The other wheel has a V-shaped edge, and is designed for grinding the pointing dies. Below it is a table which can be adjusted



vertically by a screw and hand-wheel. Upon the table is a support to receive the holder in which the die is mounted for grinding. This support is adjustable laterally to bring the dies into line with the wheel. The die-holder itself may be rotated in the support to bring the die at will into any one of the three grinding positions. When in position the die, together with its holder and support, is reciprocated to and fro past the wheel, while the whole table may be fed to and from the wheel as desired. The floor space occupied is 16 in. by 22 in., and the weight 350 lb.

TESTING NATURAL GAS FOR GASOLINE.—As plants for extracting gasoline have been erected before properly ascertaining the yield and quality of the gas, the Bureau of Mines describes in Technical Paper 87 (by G. A. Burrell and G. W. Jones) "Methods of Testing Natural Gas for Gasoline Content." The tests concern the density of the gas, which may range from 0.56 up to 1.65 (air = 1); the solubility in mineral seal oil, straw oil (a petroleum distillate), claroline oil, olive oil, alcohol, &c.; the percentage of the gas which is condensed at − 115 deg. C., when the gasoline is liquefied; and various analyses. The flow of the natural gas is determined with the aid of an "orifice meter," or, better, of a Pitot tube.

MINERAL RESOURCES OF THE PHILIPPINES.—A serious effort is being made to develop the coal and iron deposits in the Philippine Islands, says *The London and China Telegraph*. In the province of Surigao, Mindanao Island, there is, close to the shore and easily workable, a known deposit of high-grade ore, with an estimated yield of over 500,000,000 tons. There are other deposits in numerous places. So far the comparatively small quantity of native coal mined has been inferior in quality to coal of China, Japan or Australia. It is expected, however, that development of the most promising field will produce a satisfactory grade. In 1916 the Philippines produced for export 103,256 oz. of gold, an increase of 13,573 oz. over the 1915 record. There is promise of steady increase in gold production for many years to come. The outlook for transportation is also encouraging, and it was recently reported that a British line of steamers intended to run large modern vessels between Vancouver and the Far East to supplement the existing services. It is also stated that the Norwegian shipping concerns contemplate sending some of their vessels to secure Philippine trade.

THE ORDER OF THE BRITISH EMPIRE.

The long-expected list of honours conferred in connection with the new "Order of the British Empire" was published on Saturday last, but it should at once be said that it is only a first list, and that there are to follow lists conferring distinctions on those (1) connected with India, (2) with the Dominions, (3) with the Civil Service, (4) with the Military Service, and (5) with the Naval Service. The sequence of publication of these lists, however, may differ from this enumeration. "The Most Excellent Order of the British Empire" is to confer distinction on men and women who have done service for the Empire, and it will rank next to "The Most Honourable Order of the Bath." It differs, from preceding orders in the inclusion of women in their own right. The grades are, for men "Knights Grand Cross," and for women "Dames Grand Cross," both having the letters G.B.E.; the "Knights Commanders" (K.B.E.) have as their counterparts "Dames Commanders" (D.B.E.). Both sexes have "Commanders" (C.B.E.), "Officers" (O.B.E.), and "Members" (M.B.E.). The Grand Cross of the Order consists of a cross patonce, enamelled pearl, fimbriated, or, surmounted by a gold medallion, with a representation of Britannia seated within a circle, gules, inscribed with the motto, "For God and the Empire," in letters of gold enaigned with the Imperial Crown or, the whole suspended from a purple riband of the breadth of 3¼ in., passing from the right shoulder to the left side. On the left of the coat or outer garment there is to be worn an oval star composed of eight points and charged with a medallion as above. In addition there has been instituted a medal, to be awarded for service of special merit rendered to the Empire by men and women in manual and other work done for the war. Such service will include acts of great courage, sacrifice or high example; of initiative or perseverance; of skill, resource or invention. The medal is of silver, having on the obverse a representation of Britannia within the circle and motto of the Order, and on the reverse the Royal and Imperial Cypher. The first list includes a number of such awards. As might be expected, in the first list there are a large number of engineers who have done great service (in most cases gratuitously) in connection with Government Departments, and mention may here be made of these.

Amongst the Knights Grand Cross (G.B.E.) are Lord Moulton, Director-General of Explosive Supplies in the Ministry of Munitions, and Sir Eric Geddes, K.C.B., who before the war was on the North-Eastern Railway, and became later Inspector-General of Transportation, Headquarters Staff, France, and is now First Lord of the Admiralty.

Amongst the Knight Commanders (K.B.E.) are Alan Garrett Anderson, who, in commercial life, is one of the managing partners of the Orient line; he was first vice-chairman of the Wheat Commission, Board of Trade, and is now Controller, Admiralty. Thomas Bell, who has for very many years held important positions at the Clydebank works of Messrs. John Brown and Co., Limited, rising to the position of managing director there, and who, in his successive positions, has done much to bring the establishment to its high state of efficiency. During the war great work has been done by the firm for the Navy. Some time ago, however, Mr. Bell relinquished his position to become Deputy Controller for Dockyards and Shipping at the Admiralty. George John Carter, the managing director of Messrs. Cammell Laird and Co., Limited, since the end of 1912, prior to which he was at Elswick. He has greatly developed the Birkenhead works, where a large number of warships have been constructed. While holding this position he has also rendered valuable service to the Ministry of Munitions, having been chairman of the Advisory Committee on Merchant Shipbuilding. Dugald Clerk, who is well known, particularly as a great authority on internal-combustion machinery, is a member of the Panel of Board of Invention and Research, Admiralty, a member of the Ministry of Munitions Inventions Department, and also of the Trench Warfare Advisory Panel. William Collingwood, who, after a distinguished railway career here and in India, joined in 1892 the Vulcan Foundry, Limited, Newton-le-Willows, of which firm he is now managing director, and in connection with the war is chairman of the Co-operative Board of Management, Manchester and District Armaments Output Committee. Charles William Fielding, chairman of the Pyrites Sub-Committee of the Explosives Supply Department and chairman of the Materials and Metals Economy Committee, Ministry of Munitions. Alfred E. Herbert, the well-known machine tool manufacturer, of Coventry, who has done great service as Deputy Director-General in charge of the Machine Tool Division and as chairman of the Machine Tool Committee, Ministry of Munitions. John Hunter, who, prior to the war, was managing director of Sir William Arrol and Co., and chairman of the Clyde Shipbuilding and Engineering Company, has served in many capacities with distinction. His experience of constructional steel works has enabled him to do most useful work as Director of Factory Construction, and, later, he has brought equal energy and ability to bear as Director of Iron and Steel Production, Ministry of Munitions. Professor Herbert S. Jackson, F.R.S., Daniell Professor of Chemistry, King's College, University of London, since 1914, has acted as Chemical Adviser to the Optical Research Branch, Ministry of Munitions. Leonard Wilkinson Llewellyn, Director of Materials and Deputy Director-General in the Department of Munitions Supply. Sir Vincent Litchfield Raven, formerly of the North-Eastern Railway, and later Acting Chief Superintendent of the Royal Ordnance Factories, Woolwich, and now Deputy Controller of the Navy. Frederick Wilfrid S. Stokes, of Messrs. Ransomes and Rapier, inventor of the Stokes gun and other war munitions, and chairman of the East Anglian Munitions Committee.

Among the Commanders (C.B.E.) are:—Professor Herbert Brereton Baker, F.R.S., professor of chemistry, Imperial College of Science and Technology, and a member of the Trench Warfare Advisory Committee, Ministry of Munitions. Leonard Bairstow, F.R.S. Chief of Aerodynamics Department, National Physical Laboratory. Charles William Bryant, managing director of Brotherhoods, Limited. Professor W. H. Bragg, F.R.S., Quain Professor of Physics, University of London, and member of the Panel of Board of Invention and Research, Admiralty. Alan E. L. Chorlton, of the firm of Messrs. Ruston, Proctor and Co., of Lincoln, and member of the Committee of the Board of Invention and Research, Admiralty. William Duddell, F.R.S., past-president of the Institution of Electrical Engineers, member of the Panel of Board of Invention and Research, Admiralty, and member of Munitions Inventions Board, Ministry of Munitions. Lieutenant-Colonel Henry Fowler, formerly of the Midland Railway, late Director in the Gun Ammunition Division, Ministry of Munitions. Professor F. W. Harbord, who has done much valuable work in connection with the metallurgical industries of the Empire and, during the war, has acted as Consulting Metallurgist, Ministry of Munitions. Andrew Laing, who, first at Fairfield, and afterwards, for many years, at the Wallsend Engineering Works, has done an enormous amount of work, not only for the Navy, but for the merchant marine, and has, from the Wallsend establishment, turned out a great succession of turbines for British warships. Sir George Croydon Marks, M.P., a well-known engineer and patent expert, who has served not only on the Tyne Labour Commission, but also in the Labour Department of the Ministry of Munitions.

The Officers (O.B.E.) include the following:—Frederick E. W. Coller, shipyard manager, Messrs. Armstrong's naval yards; George Cumming, engineering managing director, Messrs. Harland and Wolff; George Keith Buller Elphinstone, managing director of Elliott Brothers, electrical instrument makers, Lewisham; Michael Birt Field, director of Messrs. Kelvin, Bottomley and Baird, Limited; and John Henry Silley, of Messrs. Green, Silley, Weir, for special work in connection with shipbuilding.

Members (M.B.E.) include the following:—Russell Clarke, aviation electrician, telegraphist, &c., Admiralty; William Charles Grant, temporary Admiralty overseer at Boat Yard, Abadan, Persian Gulf; J. H. Hudson, chief engineer in the fuze department of the munitions factory of Messrs. W. Cubitt and Son; Robert Clarkson Mills, in charge of drawing office, Munitions Inventions Department; and Herbert Schofield, principal of the Loughborough Technical Institute, who has erected and equipped an instructional factory and has trained workers.

We are gratified to note the inclusion of a large number of trade union leaders, as this concession to labour will be accepted as an acknowledgment not only of the personal services rendered to the State by these leaders, but also as an indirect acknowledgment of the Government's appreciation of labour generally. Included among the Commanders (C.B.E.) are: W. A. Appleton, secretary, General Federation of Trade Unions; J. T. Brownlie, Amalgamated Society of Engineers; A. Bellamy, president, National Union of Railwaymen; James Sexton, J.P., National Union of Dock Labourers; Arthur Watson, member of the Railway Executive Committee, London; Havelock Wilson, Seamen and Firemen's Union. Included as Officers (O.B.E.) are: James Brown, J.P., Scottish Miners' Association; F. Chandler, Amalgamated Society of Carpenters and Joiners; Councillor Tom Fox, British Labour Amalgamation; Samuel Galbraith, Durham Miners' Association; Alderman Gee, General Union of Textile Workers; David Gilmour, Scottish Miners' Association; Walter Hudson, assistant secretary, National Union of Railwaymen; E. L. Poulton, National Union of Boot and Shoe Operatives' Society; W. C. Robinson, Amalgamated Association of Beamers, Twisters and Drawers; Frank Smith, secretary, Shipbuilding and Engineering Federation; G. B. Stewart-Bunning, Postmen's Federation; Ben Turner, J.P., General Union of Textile Workers; Alderman Patterson Watts, J.P., C.C., National Federation of Blastfurnacemen; and R. Young, Amalgamated Society of Engineers. Included as Members (M.B.E.): Thomas Cape, Cumberland Miners' Association; Councillor William Carr, J.P., a leading trade unionist in Chester; R. H. Coates, United Machine Workers; W. F. Dawtrey, Steam Engine Makers' Society; Joseph Edwards, president of the Barrow Branch of the Steel Smelters' Union; William Hunt, Typographical Association; W. H. Jones, Mersey Quay and Rail Carters' Union; Charles Kean, Amalgamated Union of Engravers to Calico Printers; George Milligan, National Union of Dock Labourers; W. Simcox, Amalgamated Society of Engineers; and Corrie Taylor, Amalgamated Society of Engineers.

Companions of Honour.

Another new Order has been instituted, to be known as "The Order of the Companions of Honour." It carries with it no title or precedence, and is conferred on a limited number of persons. The first list includes Viscount Chetwynd, managing director, Chilwell National Shell Filling Factory, and Professor Ripper, Professor of Engineering in the University of Sheffield since 1889, and Dean of the Faculty of Applied Science, who has been acting in the important position of vice-chairman of the Sheffield Munitions Committee. There are also included four well-known trade union leaders, namely: Henry Gosling, president of the Transport Workers' Federation; William John Davies, J.P., of the Brassworkers and Metal Mechanics, G. J. Wardle, M.P., National Union of Railwaymen, and Alexander Wilkie, M.P., J.P., Ship Constructors' and Shipwrights' Association, all three for special war work in connection with recruiting and labour.

MOLYBDENUM AND FERRO-MOLYBDENUM.

Molybdenum belongs to the group of heavy metals comprising tantalum, titanium, tungsten and vanadium, which are capable of imparting special properties to steel. It was discovered by Hjelm in 1783; its symbol is Mo; it occurs as a solid; its atomic weight is 96.0; specific gravity 8.6–9.01, and specific heat 0.066. Molybdenum is a metallic element whose compounds are quite widely diffused, but its ores are very rarely found in considerable quantity. It has never been discovered in nature, but invariably alloyed with some other compound, of which it generally forms but a limited percentage. It is a white metal, hard, and somewhat malleable. The ore of molybdenum, on which the world depends for its main supply of the metal, is molybdenite, a sulphide, MoS_2, which occurs in hexagonal plates or masses, thin, foliated similar to graphite, and much resembling that mineral. This ore has a grey colour and streak, olive-coloured on white paper; it can be differentiated from graphite by its high specific gravity. Molybdenite occurs in a great variety of rocks in different parts of the world, including practically all the main groups, but its occurrence with granite and the more acid rocks, of which that is the type, is by far the most usual and typical. When molybdenum ores occur in veins, in quantity, they are usually in the form of oxides, as well as of sulphides.

Another mineral which has been found commercially suitable as a source of molybdenum is wulfenite, a lead molybdate. This ore, to be useful as a source for molybdenum, must not carry as impurities large quantities of copper, arsenic, vanadium or iron. The ease or difficulty of concentration has much to do with the feasibility of profitably mining and developing molybdenite deposits. Unless the minerals occur in tolerably large lumps, so that they can be hand-picked, it has been found somewhat difficult to discover a satisfactory method of separating the ore from the gangue material. Both the oil and the static electric methods have been used with varying success. Only rarely does the mineral occur so coarsely divided that it may be hand-picked; the ores are prepared for the market in two forms—powdered, and as ferro-alloy. The powdered form is obtained by heating some form of oxide with a reducing agent, such as carbon in the form of charcoal. The first stage produces the dioxide, which is not readily volatile. Prolonged heat and high temperature result in the production of the metal. Ferro-molybdenum, with varying molybdenum content, is made by the use of the electric-resistance furnace, either direct from the sulphide, or from the roasted high-grade sulphide. By this process the impurities can be slagged off; in the case of the powdered metal the impurities are subject to extraction by means of a solvent, otherwise they remain with the metal.

Molybdenum alloys are made in part at the Niagara Falls by means of the electric furnace, and when they are made elsewhere metallic aluminium is largely used as a reducing agent, which is also a Niagara power product. These alloys form the chief constituent of

a group of products which are absolutely necessary in the manufacture of high-speed tool steel, magnet steel and a variety of special steels. Alloys can be formed of the two elements molybdenum and tungsten by compressing a mixed powder into briquettes, and then heating them with an electric current in an atmosphere of hydrogen. Alloys can be produced varying in composition from 100 per cent. molybdenum to 100 per cent. tungsten. Thermal and microscopical analyses show that molybdenum and tungsten are completely isomorphous. All alloys of this series are malleable and ductile under proper conditions. Alloys of molybdenum and tungsten have been suggested as a substitute for platinum and its alloys, the prices of which are abnormally high. It has been ascertained that, except in two respects, molybdenum meets the requirements of a practical substitute. These two defects are its relative ease of oxidation and the difficulty with which it can be soldered; but both appear to have been overcome by coating with a precious metal or alloy.

Several restrictions on the sale of molybdenum have been published during the past twelve months. During March, 1916, *The Board of Trade Journal* published a notice prohibiting the exportation of ferro-molybdenum from Great Britain to all destinations. All supplies of molybdenite ores in Australia were requisitioned by the Minister of Defence during December, 1915, and a maximum price of 105*s.* per unit of contained metal in the ores was fixed. (See below for definition of "unit.")

Several localities for the supply of molybdenum ores may be briefly referred to. Ores have recently been found in New Zealand, at Takata, and samples assayed are stated to have contained 50 per cent. of molybdenum oxide. Ores occur in New South Wales and Queensland; works for treating them have been established in Sydney.

Several deposits of the ores occur in Eastern Ontario; these have been opened out and are being worked. There are dressing plants at Renfrew and Ottawa. Ferro-molybdenum is being made at Orillia and Belleville. The so-called "sierra" districts of Peru are highly mineralised, and contain molybdenum ores, as well as many other minerals.

For several years important molybdenite mines near Phelomarken, in Norway, have been worked in a somewhat primitive manner, but during 1916 a more modern system has been introduced. The value of the output has increased fourfold during the last two years. During 1912–13 it was only worth 4*s.* per kilogram (2.2 lb.), but the average price last year was about 1*l.* per kilogram. A large number of borings have disclosed molybdenum ores to a very considerable depth. The Dalen deposits are stated to be most important and of exceptional depth, the quality is also satisfactory; at the Kvina molybdenum mines the rock contains an average of 10 per cent. of molybdenum; whilst at the Dalen mines the percentage is probably even a higher one. Crushing machinery capable of dealing with 100 tons every 24 hours has been installed, and it is intended that the washing plant should be kept continuously at work, day and night. The product, it is estimated, will contain about 97 per cent. of molybdenum. It is proposed to establish a works for the production of pure molybdenum by an improved process.

Up to the close of 1911 the demand for molybdenum remained stationary and very limited in the United States; with the exception of some slightly increased use of the metal in Europe the outlook did not look at all encouraging. The production in the United States was very small, hardly worthy of notice—not due to any scarcity of the substance, but to small demand. More recently a larger supply was required, which resulted in an active search for molybdenum ores in the United States. During the spring of 1915 molybdenite concentrates were produced from a mine near Empire, Colorado. This is the first American mine to be extensively operated for molybdenite.

There are several known localities in the United States and Mexico where molybdenum ores could be mined profitably; they occur in more or less widely separated localities north of the international boundary of the United States and Mexico, in the Santa Rita and Patagonia Mountains, not far from the Southern Pacific Railway; in the Pinna and Santa Cruz counties, Arizona. Mines have been opened up some thirty miles south-east of the town of Tucson. Wulfenite has been found in a number of places in Utah, Nevada, Arizona and New Mexico, also to a very limited extent in California and some other States.

New and sensitive tests for molybdenum are now available; the older test yielded a characteristic blue colour, which appeared as a fugitive tint in the first stage of the reduction of molybdic acid by nascent hydrogen. It is now possible by means of an improved test to obtain a permanent blue colour; hydrazine, N_2H_4, forms a good reagent for developing it. A solution containing a trace of alkali molybdate when acidified with acetic acid, and treated with a little hydrazine sulphate and boiled, rapidly turns deep blue and retains the colour on boiling. When a slightly acid solution of MoO_3 is treated with potassium iodide (in some excess) and boiled for some time, iodine is slowly liberated and the solution turns blue. A well-known and tolerably sensitive test for molybdenum is that in which the acid solution is treated with sulpho-cyanide and a small scrap of zinc added—a crimson colour is then obtained in a few seconds. Should iron also be present the solution becomes blood red when the sulpho-cyanide is added, but when the zinc is placed in the solution it becomes colourless, through reduction to the ferrous condition, but after a few seconds becomes crimson, should Mo be present.

To test molybdenum minerals a pulverised specimen is moistened with concentrated sulphuric acid in a porcelain crucible and evaporated almost to dryness. Upon cooling, should molybdenum be present, the crucible will have a beautiful dark blue coating, which is presumed to be a mixture of oxides. This test is readily and easily performed, it is characteristic, and no element or mineral generally associated with molybdenum compounds is known to interfere with this test. The mineral with which molybdenite is most likely to be confused is graphite, which occurs in some localities in flakes, almost, if not quite, as flexible as those of molybdenite. The latter also occurs in a form which gives no suggestion to the eye of a flaky structure. There is, moreover, generally a noticeable difference in colour, as the graphite is an absolute black, whilst the molybdenite has a greyish metallic appearance; but even these characteristics are not absolutely reliable, as impure molybdenites are known which are glassy black, with no suggestion of flakiness, and which, moreover, give a black streak, though the usual streak, as stated above, of molybdenite is olive-tinted on white paper. In addition to the test mentioned above, molybdenite may be differentiated from graphite by treatment with nitric acid. Molybdenite is attacked by the acid, with a resulting white or grey powder (molybdic oxide), whilst graphite is not affected at all. Molybdenum is not affected by air at the ordinary temperature, but it slowly oxidises when heated to redness. From a concentrated solution of any molybdate nitric or hydrochloric acid causes a white precipitate to be formed.

There are many uses to which molybdenum and its various compounds have been put, as ammonium molybdate to determine phosphorus in iron; as a fire-proofing material; as a germicide; as a disinfectant; as sodium molybdate to colour pottery and porcelain blue; to dye silks and woollens; as molybdenum tannate to colour leather; and as molybdenum "indigo," Mo_3O_7, it is a useful but expensive pigment for india-rubber, which, it is stated, is not injured by its use. Molybdite, known as molybdic ochre, is a straw-colour to white mineral containing from 50 per cent. to 60.7 per cent. of molybdenum, and is considered to be a hydrated iron molybdate. There are a dozen or more known salts of molybdenum, most of them of only scientific value.

Molybdenum is one of the metals which at present commands a tolerably high price, but it is possible that by improvements in metallurgical processes it may in the not distant future be produced at a considerably lower rate. During 1910 the price ranged from 10*d.* to 15*d.* per pound for material carrying 92 per cent. of molybdenum sulphide, equal to from 93*l.* to 140*l.* per ton. During 1915 the price was about 208*l.* per ton, and at the end of 1915 and the commencement of 1916 it was 312*l.* for 95 per cent. product. The Canadian output of concentrates during 1915 approximated to 20,000 lb., valued at 4*s.* 2*d.* per lb., equal to 466*l.* per ton. During the autumn of 1916 a considerable demand for molybdenite occurred in the United States, but the supply was limited; the price per pound ranged from 7*s.* to 7*s.* 6*d.* There was a considerable demand for ferro-molybdenum at 16*s.* 8*d.* for prompt and 15*s.* 2*d.* for forward contract; towards the end of 1916 an advance in the price of molybdenite occurred up to 8*s.* 4*d.* Before the increased demand of 1916 the standard requirements for concentrates were 85 per cent. to 90 per cent. MoS_2, and except in very small amounts copper, bismuth, arsenic and tungsten, when present, were penalised. The increased demand has resulted in easier conditions. The purer the molybdenite the less treatment is necessary for the final operation of reduction. The preparation of the oxide into the commercially pure form is not an easy one; it is effected by roasting the sulphide first to an oxide and then leaching the mass with ammonium hydro-oxide, which dissolves the oxide and forms ammonium molybdate. Copper oxide forms an objectionable constituent. In the determination of phosphorus in molybdenum compounds any molybdic acid separating out of the acid solutions containing phosphorus carries a considerable amount of this element out, forming phospho-molybdic acid.

The terms "unit" or "content" are frequently used in quoting the price of molybdenum ores; the former refers to the price per net ton of ore guaranteed to contain a given percentage, possibly with bonus or penalty per unit for anything over or under the given percentage. The word "unit" is used in the same sense as per cent. The "content" system is a somewhat simpler mode of quoting, thus: 3*s.* per pound for MoS_2 contained in concentrates of 90 per cent. molybdenum sulphide. An example will make the system clear. If 10 net tons of 93 per cent. concentrates are purchased, then that percentage of 22,400 lb. would be 20,832 lb., which, at 3*s.* per pound, would amount to 3,124*l.* 16*s.*

With such limited natural supplies of molybdenum ores it is important to prevent loss, or to reduce it to a minimum. By the flotation process waste has been prevented, as it has been successfully applied to molybdenite ores on a large scale without the use of either acid or oil. The antagonism of the surface of the mineral itself to wetting action is sufficiently pronounced to enable it to be floated off under the conditions in practice. Even after having been crushed wet and passed through an ordinary wet concentration mill it may still be floated by bringing it in a suitable manner upon a water surface. Thus at one mine the tailings from a wolfram-bismuth concentrating mill, all passing a 20-mesh and containing only 2 per cent. to 4 per cent. of molybdenite, are treated by passing them over suitable flotation boxes without the aid of acid or oil. The flotation appliances consist of a series of cone-shaped boxes, with the usual overflow, the ore being fed on to the water surface by means of an inclined plane; the molybdenite, in the form of a thin scum, passes over the overflow lip, whilst the tailings are discharged at the bottom of the boxes. The necessity for a rapid forward movement of the flotation surface involves the use of a somewhat large overflow of water, which is contaminated with the gangue of the ore. Instead of the molybdenite overflowing with the water, it may be intercepted by a belt, on to which it floats, and it is then carried across the overflow lip, whilst the water passing over the lip is free of molybdenite. The clean molybdenite is washed off the take-off belt into a settling trough, whilst the gangue passes out at the bottom of the flotation boxes. At an American mine molybdenite and pyrite are being successfully separated by the flotation process. The ore, carrying about 25 per cent. of iron pyrite, has been separated by the use of a weak hot solution of sodium bichromate. Molybdenite is so much more readily floated than pyrite, that a solution of sodium bichromate is almost unnecessary in many cases.

AMERICAN FIRE-BOX STEEL.—For fire-box steel, for both locomotive and stationary service, the manganese requirement under specifications of the American Society for Testing Materials, says *The Iron Age*, has been put tentatively at 0.30 per cent. to 0.60 per cent.

THE LATE MR. JAMES RYDER BUTLER.—We regret to have to record the death, which occurred at his residence, on Sunday, the 19th inst., of Mr. James Ryder Butler, the founder of the firm of J. Butler and Co., machine tool manufacturers, Halifax. Commencing life in very modest circumstances, Mr. Butler succeeded by hard work and diligence in building up the well-known Halifax machine-tool works, and by his kindliness and generous disposition he enjoyed for the whole of his life the respect and affection of everyone who came in contact with him. As a boy he was employed for a short time at *The Halifax Courier* office; then, for a short time also, by Mr. J. Jessop, chemist, Halifax. He afterwards was apprenticed with Messrs. J. Crossley and Co., machinery makers, Bank Bottom, spending his evenings in technical studies. On completing his apprenticeship he entered the jacquard department of Messrs. J. Crossley and Co., Dean Clough, where he subsequently became foreman. He started business on his own account forty-eight years ago, specialising in the making of jacquards. In 1872 he entered into partnership with the late Mr. George Dennis, the firm being styled Dennis and Butler. In 1879 the partnership was dissolved, Mr. Butler continuing on his own account in the machine tool business. In 1887 he took into partnership Mr. Henry E. Hodgson, when the works were extended and made to include an iron foundry. About six years later the partnership was dissolved, Mr. Butler continuing to work the business on his own account, until he was joined by his two sons, Messrs. Harold and Herbert Butler. Mr. Butler was 75 years of age at the time of his death, and although he had not taken an active part in the business for some time past, he had always kept in close touch with it. Under his guidance, and subsequently with the aid of his sons, the firm made great progress; it now employs about 500 hands. The deceased was past-president of the Halifax Engineers Employers' Federation. From 1892 to 1895 he was a member of the Halifax Town Council, and was for a time on the council of the Halifax Chamber of Commerce. In religion Mr. Butler was a Non-conformist, but he willingly, on all occasions, assisted any and all the churches in the circuit of his own church. He will always be most kindly remembered by a very wide circle.

MULTIPLE-ARCH DAMS ON RUSH CREEK, CALIFORNIA.*

By L. R. Jorgensen, M.Am.Soc.C.E.

(*Concluded from page* 185.)

Gem and Agnew Lake Dams.—The design shown in the illustrations on pages 183, 184, and 185 *ante* was made by the writer for the Pacific Power Corporation, of Bodie, Cal., to be used for the construction of their Gem and Agnew Lake dams on Rush Creek, Mono County, California. Fig. 7 is a plan of the Gem Lake dam and dam site, and Fig. 8 shows the Agnew Lake dam site. On Fig. 7 is also indicated the outlet works, consisting of a concrete chamber provided with a row of iron bars in front, and a 48-in. steel pipe laid through a tunnel for about 300 ft. This pipe line terminates in a power-house (see Fig. 19, page 225), 1,808 ft. below (in elevation) the top contour of the lake. The maximum height of any individual arch of this dam is 84 ft., and the vertical distance from the deepest point in the foundation to the crest is 112 ft. The length across the dam site at the crest (elevation 9,053) is 700 ft. The reservoir created has a capacity of 17,000 acre-ft., and is capable of regulating Rush Creek to yield an estimated average flow of 45 sec.-ft. The drainage area above the dam is 22¾ sq. miles, and is on the eastern slope of the Sierra Nevada Mountains. Its elevation ranges from 9,000 ft. above sea-level at the dam to 12,000 ft. along the crest of the mountains. The precipitation at these elevations is still high, but decreases very rapidly from the foot of the steep mountains out over the desert immediately east, at elevations ranging from 6,000 ft. to 7,000 ft. above sea-level.

The rock at the dam site, for the most part, was exposed bed-rock worn clean by glacial action. Some excavation, however, was necessary in the stream bed and through a rock slide at the north abutment. The building material for the dam was found near by. The sand was taken from the shore of the natural lake. The rock had to be hauled a short distance on a tramway, first from the outlet tunnel dump (limestone), and later from a large rock slide (granite) about 2,500 ft. away. All available materials in the neighbourhood, especially the different sand deposits, were tested before any particular material was selected for construction. As the sand deposit along the shore of Gem Lake was good, it was used. This sand was first pumped, and later shovelled, from the lake, and transported to a storage pile near the mixing plant. This lake sand, which contained 3¼ per cent. of clay and 1 per cent. of dirt, was mixed with sand from the rock crusher (all particles being less than ¼ in. in diameter) in the proportion of about three-fourths of lake sand to one-fourth of crushed rock sand. This gave a good combination, both as to strength and watertightness.

Compression tests on 6-in. cylinders were made as the

* Paper (slightly abbreviated) read before the American Society of Civil Engineers.

Fig. 8.

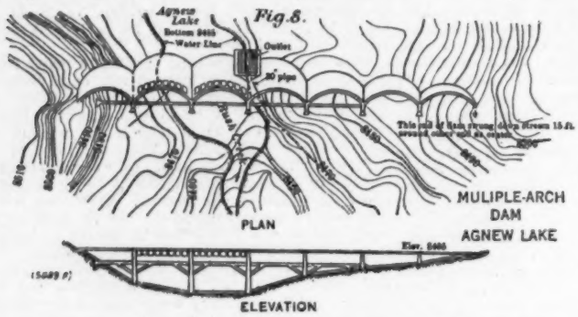
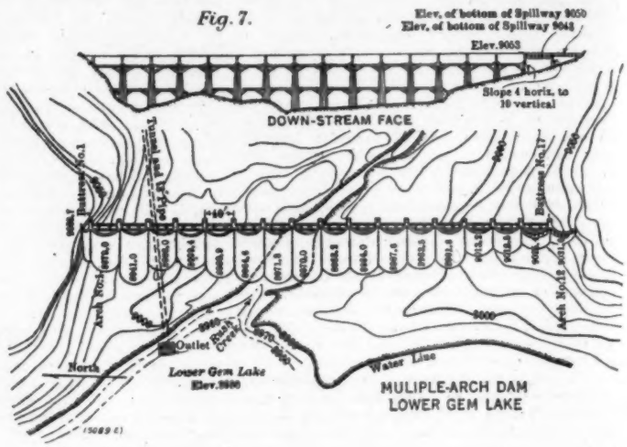


Fig. 7.



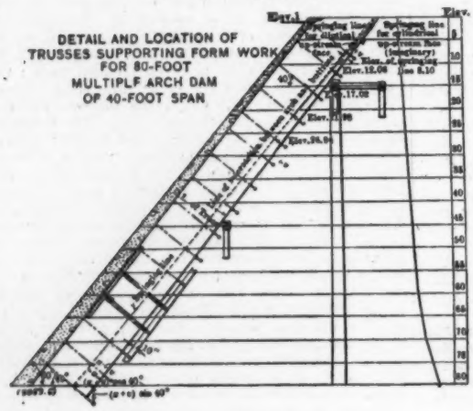


Fig. 9.

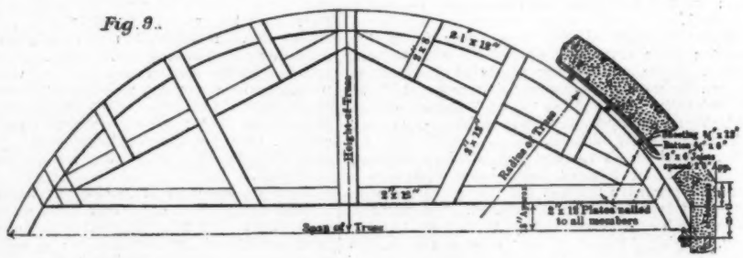
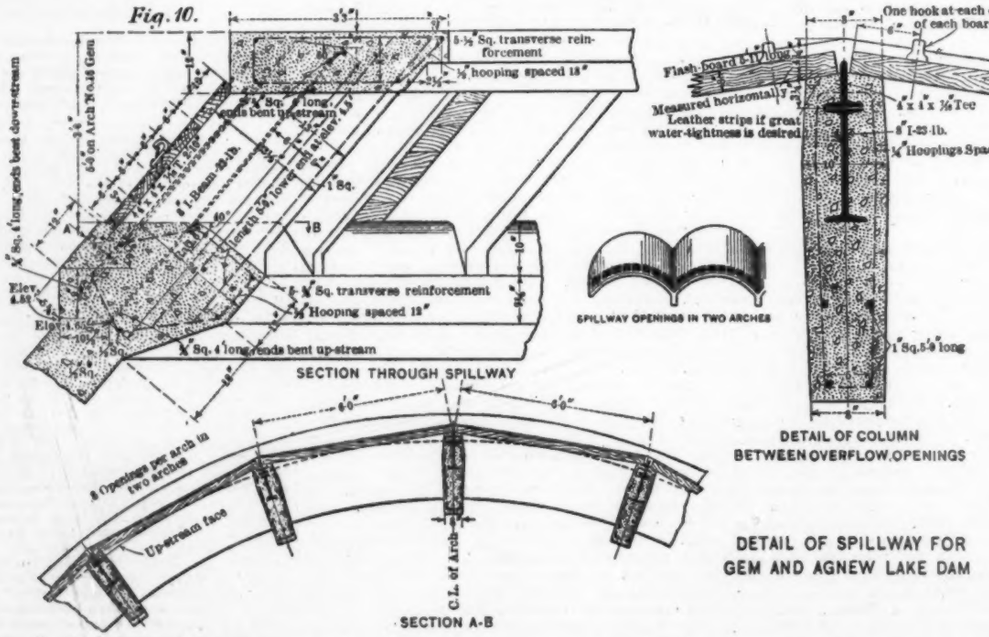


Fig. 10.


SECTION THROUGH SPILLWAY
SPILLWAY OPENINGS IN TWO ARCHES
DETAIL OF COLUMN BETWEEN OVERFLOW OPENINGS
SECTION A-B
DETAIL OF SPILLWAY FOR GEM AND AGNEW LAKE DAM

work progressed, using Bear brand Portland cement, Gem Lake sand, and crushed rock, in the proportions 1 : 2 : 4, and averaged about 900 lb. per square inch for crushing at the age of 14 days.

A 1 : 2 : 4 mix was adopted for the arches and struts, and a 1 : 2½ : 5 mix for the buttresses. The actual proportions, however, were sometimes changed, but 1½ barrels of cement for the arches, and 1¼ barrels for the buttresses were used always. The rock was crushed in a gyratory crusher, and separated into three sizes through a revolving screen having 1½, ¾ and 1¼-in. meshes. The rejects from the screen went into a jaw crusher, the jaws of which were set to give a maximum size of 2 in. The distribution of the concrete to the different arches and buttresses was done with two-wheeled push carts and short chutes.

During the construction period, in the summers of 1915 and 1916, tension tests were made of cement briquettes in a small field laboratory. Much attention was also paid to the sand used, and 1 : 2 and 1 : 3 mortar briquettes were tested frequently; silt analyses were made as the work progressed.

The reinforcement placed in the dam consisted of high-carbon steel bars, either corrugated or twisted. As the position and details of these bars are fully shown in the figures, no further explanation need be given.

The trees standing on the reservoir site were cut down, sawed into lumber in a mill erected on the ground by the contractors, and used for the forms. Large cone-bearing trees can be found in this neighbourhood up to

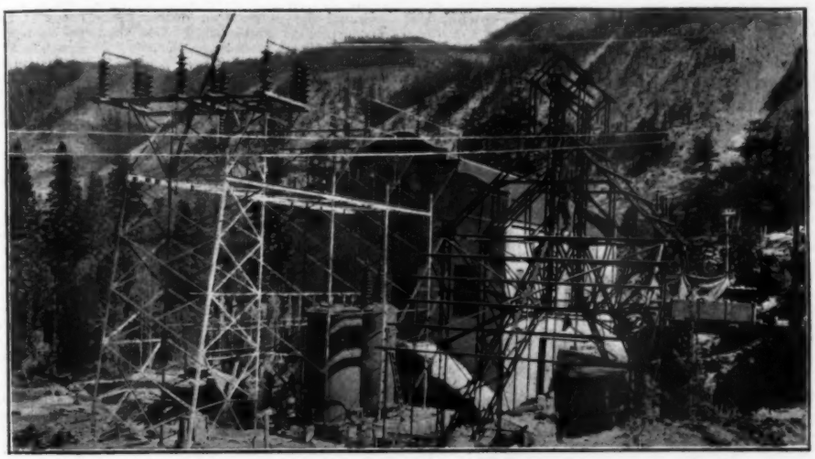


FIG 19. POWER HOUSE AND OUTDOOR TRANSFORMER INSTALLATION.

elevation 11,000 in fairly large quantities, but not of the best quality. The lumber proved to be good enough for form work, and was used green, and on that account ¾-in. by 4-in. battens were placed on the under side of the sloping arch to avoid the leakage of grout between the boards when shrinkage took place. These battens also helped to give an even, circular shape to the outer ¾-in. by 12-in. boards constituting the form for the down-stream face. This sheeting was supported on 2-in. by 6-in. studs, 2 ft. 6 in. apart, toe-nailed to the wooden arch trusses shown in Fig. 3, on page 183 *ante*, and Fig. 9, annexed. These trusses were 5 ft. apart in elevation, and a little more than 6½ ft. apart, measured along the arch slope. The form work for the up-stream face consisted also of ¾-in. by 12-in. boards nailed to 2-in. by 6-in. studs, which in turn were nailed to circular boards at regular intervals. This outside form was held away from the inside form (down-stream side) by wooden distance-pieces of the proper length, which pieces were removed just before the concrete reached them (see Figs. 12 and 14, on Plate XVIII).

A 1 : 2 plaster coat of cement mortar ½ in. thick at the crest, and increasing to ¾ in. thick 80 ft. below, was put on the up-stream face with a cement gun (see Fig. 15, Plate XVIII).

At the south abutment the two last arches are provided with spillway openings. These spillway openings can be closed with loose flash-boards. This it is proposed to do toward the end of the wet season, so as to fill the reservoir to within, say, 1 ft. of the crest of the dam, thereby gaining 2 ft. of water over an area of nearly 300 acres. The spillway is shown in detail on Fig. 10. [Reproductions of photographs showing various stages in the construction of the Gem Lake and Agnew Lake dams will be found in Figs. 11 to 18 on Plate XVIII.]

Cost.—The Gem Lake dam contains 8,537 cub. yards of concrete and 82 tons of reinforcing steel. The contract price was 22 dols. per cubic yard, including cement, forms, plastering the up-stream face, and all tools and materials except the reinforcing steel, which was paid for as an extra at the rate of 110 dols. per ton in place. The excavation, of which there was only a limited quantity, was also paid for as an extra. The high cost is explained by the fact that freight rates were high, and, further, that the distance from the railroad to the power-house site at Silver Lake, at the foot of the steep mountains, was nearly 60 miles over desert roads with heavy grades. From the power-house site a tramway, approximately 4,500 ft. long, took all supplies up the mountain side to Agnew Lake, 1,250 ft. above. All the outlet of this lake the Agnew dam, a smaller structure, 30 ft. high and 280 ft. long, similar in design to the Gem Lake dam, but having only one strut, was built at the same time and at the same unit prices, in order to increase the capacity of the natural lake. All material for use in the construction of the Gem Lake dam was brought across this lake on a barge, for a distance of about 2,000 ft., to the foot of another tramway terminating at the site of the Gem Lake dam, 550 ft. higher in elevation. The cost of these tramways was not included in the price per cubic yard for concrete, but was paid for as an extra. These tramways were also necessary for the construction of the pressure pipes to the power-house, one from Gem Lake and one from Agnew Lake, and would have had to be built independent of the dams.

For the long haul across the desert from the Southern Pacific Railroad station at Benton, Cal., to the power-house at Silver Lake, six 75-h.p. C. L. Best tracklayers, burning distillate, were used, each hauling three trailers. The net load was as close to 20 tons as practicable, and the time necessary to make one round trip was about 6 days of 12 hours, including loading, unloading and ordinary delays. The speed per hour of these tracklayers was 2½ miles on high gear, and 1½ miles on low gear. The contractors found that the cost to them for hauling this distance was at the rate of 13.50 dols. per ton. The hauling of the cement and materials for the dams was not paid for extra, but included in the price for concrete in place.

A rock-fill dam on the same site would have had to be built for 2.15 dols. per cubic yard (construction cost), including the watertight face and hand-laid rock, in order to be on equal terms, as to cost, with the multiple-arch dam built. In the writer's opinion, this would not have been possible in this place. In any locality where cement can be laid down at less cost than in this case, the relative cost of a multiple-arch dam and a rock-fill dam will be still more in favour of the multiple-arch dam.

The writer furnished the designs and also supervised the construction of the dams. Mr. C. O. Poole was chief engineer for the whole development; E. J. Waugh, Assoc.M.Am.Soc.C.E., was resident engineer; L. B. Curtis, M.Am.Soc.C.E., field engineer; and Mr. F. O. Dolson, superintendent of construction. Messrs. Duncanson Harrelson Company, of San Francisco, were the contractors for both dams.

AMERICAN CONCRETE SHIPS.—An experimental hull of concrete is to be built by the San Francisco Shipbuilding Co., and towed to Hawaii. If the test is successful the hull will be brought back and fitted with engines.

THE LATE MR. ALEXANDER BREMNER.—We regret to have to announce the death of Mr. A. Bremner, at the comparatively early age of 58, which occurred very suddenly at Tarbert, Loch Fyne, on August 25. Mr. Bremner had been 30 years in India, working at the extension of the railways of the Empire. He worked at first in Kathiawar, and was engaged later on the Delhi-Simla line. During the latter part of his career he was a district engineer of the Great Indian Peninsular Railway, familiarly known as "Gip"; he resided first at Jhansi and later at Jubbulpore. Owing to failing health, he retired in 1916 and spent a year in Jersey. He underwent a severe operation in May, from which he only partially recovered. Mr. Bremner belonged to a family in which all the men are engineers. His cousin, Mr. J. R. Bell, the original of Rudyard Kipling's "Bridge-Builder," originated the Bell-bond method of preventing Indian rivers leaving their beds by means of stone dykes or banks. Both Mr. Bell and Mr. Bremner were grandsons of the distinguished Scottish engineer, harbour builder and raiser of sunken and stranded vessels, James Bremner, of Wick.

PROPERTIES OF GASOLINE.

THE increased demand for gasoline has led to an increased production of oil in the American mid-continent fields and, further, to modifications in refining processes, so as to make considerable percentages of what used to be sold as burning oil available as fuel for internal-combustion engines. Under the circumstances it became all the more desirable to arrive at something more definite than the standard dictionary definition of gasoline as "a highly volatile mixture of fluid hydrocarbons obtained from petroleum." In order to fix the properties of gasoline it was first of all necessary to investigate the properties of what is actually sold under this name. For this purpose the Bureau of Mines (Technical Paper 163, by W. F. Rittman, W. A. Jacobs and E. W. Dean) purchased or obtained samples from retailers, filling stations and refiners, and submitted 52 of the samples to a comprehensive series of tests, and tested 150 more samples as to gravity only. The samples were distilled; evaporation losses were determined; the percentage of unsaturated hydrocarbons was ascertained by the sulphonation method and by the determination of the iodine numbers; the calorific value was determined in a calorimeter, and finally engine tests were made. The calorific values per unit weight of all the samples did not differ by more than 1.5 per cent., the powers developed in brake tests did not differ by more than 10 per cent. (with a possible error of 3 per cent. or 5 per cent.), and the sulphur content was always practically negligible; these three tests may hence be dispensed with in ordinary practice.

The volatility of the gasolines varied within wide limits. The lower limits of the boiling-points ranged from 50 deg. up to 75 deg. C., the upper limits from 125 deg. up to 175 deg.; some casing-head gasolines—which are always blended—even contained products boiling above 200 deg. C.; the large percentages of constituents of both low boiling point and high boiling-point are characteristic for blended gasolines. There was also large variation as to specific gravity and as to content of unsaturated hydrocarbons, and these three properties proved in general sufficient to settle the source, method of production, and probable utility of any sample. The density, the Bureau rightly insists, should be referred to water and not be given in degrees Baumé. The iodine numbers of uncracked gasolines varied from 1 to 6.5; in cracked specimens the iodine number rose to 40, and even 60. The relative evaporation losses seemed to be approximately in direct proportion to the magnitude of the distillation cut up to 50 deg. C.

Some of the general conclusions drawn from these tests are very interesting. Gasolines of a narrow range of boiling-point and free from unsaturated compounds, properties possessed by "high-test" gasolines (density about 0.683) obtained by "straight" distillation (without cracking), command, in general, high prices. But the high-test gasolines are only slightly, if at all, superior to cheaper gasolines, and then only on a weight basis, whilst they are sold by volume. The high-test gasolines, indeed, offer the advantage that they yield maximum efficiency over a large range of engine conditions. Run with proper skill and care and adjustment, engines of modern construction are, however, no longer restricted to high-test fuels. Nor is a high degree of saturation any longer imperative. Gasolines of heavy gravity and cracked and blended gasolines, relatively rich in unsaturated hydrocarbons, can be burnt in engines without inconvenience.

BOILER CORROSION.—A case of boiler corrosion which was brought by Mr. B. G. McLennan before the Society of Chemical Industry (see Journal of the Society, August 15, 1917) illustrates rather than elucidates the difficulties of such problems. Previous to 1910 a range of Lancashire boilers was fed with water of ordinary hardness which was not free from the oil of condensed steam; a thin layer of hard scale settled in the boilers. Another water, chemically softened and freed of all oil, was then adopted; no hard scale formed, but a soft scale appeared in the preheater and economiser. To eliminate this deposit the alkalinity of the feed water was further increased. The soft deposit decreased, no hard scale formed, but corrosion made its appearance in the boiler, and was noticed for several years, though to different extents, especially on the tubes and on the shell near the tubes, as well as in the lower drum. Mr. McLennan suggested that corrosion by oxidation began when the caustic water had removed the film of oily residue on the iron. Since the actual boiler conditions hardly admit of investigation, he experimentally tried whether the corrosion was essentially due to oxygen or to electrolysis. For this purpose he suspended two bars cut from the same boiler plate by iron wires in a bell jar filled with a water like the feed water as it was, or concentrated, from which he expelled all oxygen by boiling and by currents of hydrogen. After eight days he found distinct corrosion and rust, but no free oxygen; after 26 days there was more corrosion and a little free oxygen. Small electric-motive forces were observed, up to 19 millivolts; the bar which was anode first became cathode afterwards. Mr. McLennan concludes that the action is electrolytic, due to local currents, and that the electrolysis of the water supplied the oxygen for the oxidation of the water. Mr. J. Miller objecting that the oil seal used would not really be impermeable to atmospheric oxygen—an interesting point of some novelty—McLennan repeated his experiments, avoiding both the oil layer and the hydrogen, which might act as depolariser. He again observed potential differences and corrosion. The presence of sodium carbonate, which would dissociate in the hot water—not of caustic soda—would favour the corrosion.

A METHOD OF AVERAGING.

To the Editor of Engineering.

Sir,—When examining the results of experiments, &c., of which an average value is required, the arithmetical mean is apt to be misleading, owing to the inclusion of records giving exceptional values. By plotting them as in Fig. 1 and drawing a horizontal line through their mean positions it is sometimes possible to minimise this error; but its height is, after all, determined by an approximate guess.

I have for many years used a method, illustrated in Fig. 2, for determining more accurately the true mean after eliminating exceptional records, and, in view of its usefulness, I have been urged to publish it, which I have much pleasure in doing.

As I have no other figures by me, at the place where I am writing, which are suitable, I will take as an example a number of breaking tests of Portland cement, made after 28 days in each case.

In Fig. 1 these are plotted at equal intervals along a base-line, the height of which, for convenience, has

Fig. 1.

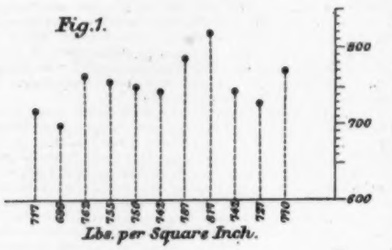
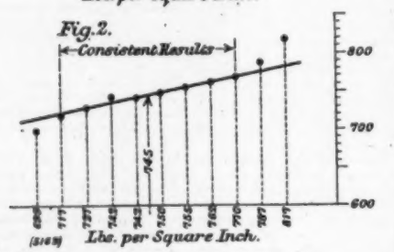


Fig. 2.



been taken as 600 lb. per square inch. (The lines on a sheet of ruled foolscap will be found convenient for this purpose.) The ordinates are in the order in which the tests were made, during a period of one month, and represent pounds per square inch of section. If, instead of grouping them at random, the results are arranged *in order of magnitude* at equal distances apart, Fig. 2 will be obtained. It is now easy to draw a *straight* line through a large proportion of the dots with certainty as to its position. It will not usually be horizontal, though it would be so with experiments giving identical results.

Any dots at the ends of this line which depart much from it should be neglected, leaving those indicated as giving consistent results. The centre of the line through these latter will give the mean height required, which in this case is 745 lb. (or strictly 745.6 lb.) per square inch, instead of the arithmetical mean, which is 751.6.

Of course, it is always advisable to ascertain as far as possible the reason for the discrepant results at the two ends of the line, but unless special circumstances are known which require their inclusion, it is generally safe to discard them as described.

The slope of the line in Fig. 2 depends largely on the vertical scale selected, and also on the pitch of the ordinates, but if these are always taken the same for a given class of experiment, the reliability of the results may be judged by the degree of approach of the mean line to horizontality.

Yours faithfully,
C. H. Wingfield.

Westminster, July 18, 1917.

WANTED: A NATIONAL ASSOCIATION OF ENGINEERING FOREMEN.

To the Editor of Engineering.

Sir,—I see in this morning's paper that the Minister of Munitions has appointed a Commission to inquire into the rates of remuneration paid to skilled men, with special reference to the discrepancy between the earnings of such men and those of less skilled men engaged on a system of payment by results, and the possible effect of these circumstances in view of the decision to abolish leaving certificates. Here we have an admission that things have not been working quite satisfactorily in the past. Engineering foremen, by virtue of their position if nothing else, are certainly the highest class of skilled men, and therefore the statements I have made in my letters published in your issues of July 27 and August 10, are fully substantiated. I have received quite a number of letters on the subject, and trust I shall receive more. It is, however, up to foremen in all large centres to meet at once and to collect their best talent, so that representations to the above Commission can be made without delay. The trade unions will no doubt appear in full force, but their case cannot be dealt with on the same lines as that of foremen and workshop managers.

I am, yours faithfully,
Henry Greenly,
Member: R.A.F. Foremen's Association.
Ashley-road, Farnborough, Hants, August 25, 1917.

NAVY HONOURS AND DECORATIONS.

A list of Navy Honours and Decorations was issued on Thursday, principally in connection with minor operations. The Victoria Cross has been awarded to the Skipper of the drifter Gowan Lea, Joseph Watt, R.N.R., in connection with the action in the Straits of Otranto on May 15; while the captain of H.M.S. Dartmouth, Captain Albert Percy Addison, R.N., has been made a C.M.G. in connection with the pursuit of and running fight with Austrian cruisers which had attacked the drifters in the Straits, and "especially for his excellent judgment and work in bringing his ship safely into port, when she had been torpedoed by an enemy submarine on her passage back, after the cruiser action was over." The engineer-commander of the ship, Frank Rheuben Goodwin, gets a D.S.O., for "exceptional work under very trying conditions in bringing H.M.S. Dartmouth to port after she was torpedoed." In connection with the same engagement conspicuous gallantry medals have been given to two enginemen of the drifters: Firstly, Engineman Charles Mobbs, R.N.R., who "remained at his post until the main steam pipe was shot away, when he was forced to leave the engine-room, but as soon as possible he returned and put out the fires. He also went in a small boat and assisted to plug holes in the ship's side, thus enabling her to reach port safely." The other engineman is Walter Watt, R.N.R., of whom it is said "the crew were taken prisoners, but on their way to the Austrian cruiser Watt jumped overboard. He was recaptured, and when alongside the cruiser he again jumped overboard and escaped. He was picked up by another drifter 1½ hours later." A number of honours were given in connection with actions with enemy submarines, and these include Distinguished Service Medals to Engine-room Artificer Hugh Robinson, R.N.R., and Chief Engine-room Artificer Robert Arthur Dunlop. Amongst those mentioned in despatches is Engineer-Lieutenant Neal Shaw McKinnon. The Emperor of Japan has granted decorations of the "Order of the Rising Sun" and of the "Order of the Sacred Treasure" to a number of admirals, captains, &c., of the Navy, and the "Order of the Sacred Treasure" of the Third Class has been given to Engineer-Commanders William J. Duffell, R.N., Walter R. Parnall, R.N., and George R. Byles, R.N.

School of Architecture.—The syllabus of the School of Architecture, University College, Gower-street, London, can now be obtained from the Provost, and applications for admission must reach him before September 20. The new buildings are now ready. The greater part of the student's first year is devoted to "Orders"; the second to practical work, and the third to academic design. Architectural students study building design, especially in relation to steel and reinforced concrete, in the engineering laboratory, with the engineering students. They also attend the Trades Technical School in Great Titchfield-street.

German Waterways.—An article in *The Board of Trade Journal*, quoting from the issue of *Handel und Gewerbe* of July 28, says that the Imperial authorities intend to make a contribution to the cost of the plans for the development of the German waterways. According to this publication, there appears in a third supplement to the Imperial Budget for 1917, which has been passed by the Bundesrat and laid before the Reichstag by the Imperial Chancellor, the non-recurring item of 1,200,000 marks as a contribution to the working out of plans for the development of the German system of waterways. After a preliminary statement as to the importance of the German waterways, and especially the economic advantage to be derived from their connection with the Danube, the following indication of the attitude of the Imperial authorities towards the whole question is given:—The Imperial authorities will contribute to the cost of the working out of plans whose execution would be to the economic advantage of Germany as a whole. Such plans comprise, in the first place, the connection of the Rhine with the Danube by the Main, the Neckar or Lake Constance; and, further, the provision of waterway connections in the watershed of the Weser, the Elbe and the Oder. The preliminary allocation of the 1,200,000 marks is as follows: For plans for (*a*) a waterway for large vessels from Aschaffenburg to the frontier of the Empire below Passau, 700,000 marks; (*b*) a waterway for large vessels from the Rhine to the Danube, by way of the Neckar, including rendering the Danube navigable from Ratisbon to Ulm, and connection of the Upper Rhine with the Danube *via* Lake Constance, 100,000 marks; (*c*) other schemes, 400,000 marks. The detailed allocation of these amounts, which in no case are to constitute more than two-fifths of the outlay necessitated, is to be arranged by the Imperial authorities with the authorities of the particular States in question. The Imperial participation in the outlay on plans is solely to ensure the testing of the feasibility and value of the separate schemes from the point of view of Imperial interests; it in no way prejudices any future decision on the part of the Imperial authorities as to whether, and to what extent, they should undertake part of the costs of execution of one or other of the schemes.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

South Yorkshire Coal.—With the definite conclusion of the arrangement with the Coal Controller that Sheffield shall be regarded as a special area for the purposes of distribution, there is a more promising tone in the market and the outlook is considered to be distinctly brighter in the matter of winter supplies. At no time since the outbreak of the war, it can be said with safety, has Sheffield had more than sufficient coal for industrial purposes alone, leaving out altogether the question of household requirements, and if the present novel undertaking had not been come to there was a distinct prospect of there being a shortage, if only through congestion on the few railways that would have been permitted to accept the coal in transit. Happily the danger was foreseen, and has been admitted by those in authority to be a real one. The promises obtained have not had the immediate effect of relieving the open market, or lightening the demand on contract accounts. Hard coal pits are working at the utmost pressure to fulfil all orders, and there is little but what is absorbed from day to day, with the consequent depletion of stocks at the pit tops. Best qualities of steam hards are rather difficult to secure outside direct contracts, and even in some of the latter cases the tonnage arriving is not up to the specified standard. Cobbles, nuts and slacks are much in the same position, the latter having made a strong recovery on the position of a few weeks ago, and now possessing a firm tone. Householders continue to seek full tonnage for storing purposes, but find the inevitable delays between orders being accepted and delivered rather exasperating. Gas companies are asking for an improved percentage on their contracts now that the winter season is arriving, but this cannot be forthcoming at once. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire best brights, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire house coal, 17*s.* to 18*s.*; best large nuts, 16*s.* 6*d.* to 17*s.* 6*d.*; small nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; and smalls, 7*s.* 6*d.* to 8*s.* 6*d.* per ton at the pit.

Iron and Steel.—Practically all traces of the holiday interruption have now disappeared, and works and men are settled down to a long run, with prospects of a new record in the monthly records of output which are duly kept and noted by the local committee acting on behalf of the Ministry of Munitions. It is true that outside direct war work business is falling-off, but this is due more to a want of facilities in the shape of material and labour rather than to any shortage of orders. It is satisfactory to note, nevertheless, that the export trade is being maintained at a good level in the face of increasing difficulties. The Government is, of course, withholding permits for the overseas transport of iron and steel and goods made of these materials. All classes of raw material are by no means to be had in abundance, and these precautions are necessary if we are to have the supplies we require. The output of pig-iron by both the Lincolnshire and Derbyshire furnaces has improved somewhat of late, following the restarting of furnaces that have been undergoing alterations and extensions. Basic sorts can also be had in good tonnage, as well as the increased output of forge and foundry brands. Merchant bar iron is not easy to get. The call for steel is reflected in the tightness prevailing in all quarters. The work of national importance now carried on in most of the large works is of the most urgent type, and has much in common with the marine work in the shipyards, the aeroplane production, tanks and motor cars. Deliveries of steel are almost out of the question for other than these classes. The current prices of steel at the works are: basic billets, 11*l.*; Bessemer acid, 14*l.* 10*s.*; Siemens acid, 15*l.* 10*s.* Much new plant has been put down to improve steel production, and further efforts are to-day being made in this direction. One interesting development has resulted in Messrs. Steel, Peech and Tozer, of Rotherham, running two 50-ton open-hearth furnaces at their latest extensions. Agricultural engineers continue to be busy, and the assistance of the machinery department of the Ministry of Munitions has been very valuable in securing them the necessary quantities of material, particularly steel. Both cutlery and plate makers are perturbed about the problem of material. Overseas orders have come to hand for engineers' tools of all classes, sheep shears, plane irons, motor-car work, saws, files, knives, machetes, cutlery, hardware and steel.

Sheffield Trade Matters.—Sheffield Forge and Rolling Mills have had a busy year, and at the annual meeting, which has been held since these notes were last compiled, it was decided to pay a dividend of 15 per cent. free of tax. Mr. S. Meggitt Johnson, the chairman, contrasted the present happy position with the times 25 years ago, when the shareholders had to go without dividend on several occasions. The history of the company for the past year had been, he said, one of important extensions, and in a few months they would have erected on a new large site a modern mill, fitted with up-to-date machinery, which would be a valuable asset both now and after the war.

Martell Scholarship, 1917.—The Martell Scholarship has been awarded by the council of the Institution of Naval Architects to Mr. H. C. Carey, of Chatham Dockyard. The scholarship is of the value of 100*l.* per annum, and, subject to the regulations governing the same, is tenable for three years. The Earl of Durham prize has been awarded to the second candidate in order of merit, Mr. H. D. Leggett, of Portsmouth Dockyard.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—It is a significant fact in connection with the local steel-making industry that the only change which goes on from week to week is a steadily increasing all-round activity. The continued rush of war work in the allied industries keeps every establishment fully occupied, all being controlled by the demand for material for purposes closely associated with the war. It is authoritatively asserted that never before in the history of the trade has steel played so important a part in the affairs of the nation. Notwithstanding the recent additions to plant and machinery and the corresponding development, makers still find it difficult to satisfy completely the demands of Government, and that although the quantity supplied to Allied countries is small. As things now are the entire available plant is running wholly on Government account or under Government supervision. Ship plates and sections, and steel for shell bars, still rank first in importance.

Malleable Iron Trade.—Unfortunately, through scarcity both of material and of labour, the output of malleable iron has decreased very considerably, and at the moment stands at much below the average. In consequence, less than ever is available for other than war purposes, and so far as export is concerned the outlook is duller than at any other period during the past three years. Prices, however, are firm, and "Crown" bars are quoted at 15*l.* 15*s.* to 16*l.* per ton.

Scotch Pig-Iron Trade.—As might well be expected, there is no falling-off in the demand for all brands of pig-iron, hematite in particular still taking first place. Indeed, so urgent are the necessities of the steel works employed on Government account that there is nothing unusual in the pigs going hot from the beds into consumption. This marked activity has further curtailed ordinary business, both home and export. There is little prospect, however, of any immediate improvement—so long as the present urgency exists things must just run the only course possible. Except where officially fixed, rates continue firm.

Industrial Development on the Forth.—A meeting of a particularly interesting character has just been held in the Leith Council Chambers on the initiative of the Provosts of Leith, Kirkcaldy and Grangemouth, three of the most important seaport towns on the Firth of Forth. Representatives from a number of other towns closely associated with the naval base at Rosyth and the fleet stationed in the Forth, were invited to take part in the proceedings. Provost Malcolm Smith, of Leith, who presided, explained that the idea of the conference was to consider the best method of bringing before the notice of Government the needs arising in connection with the work now being carried on on the Forth, referring especially to the existing facilities for docking, shipbuilding, ship repairing, &c. A motion was moved and unanimously carried whereby the conference offered to prepare and submit to Government a statement showing the present facilities available both at and adjacent to the towns on the Forth, as well as the possibilities of these if properly developed. After discussion it was agreed that suggestions and reports might be sent to the town clerk of Leith, and that afterwards a full report of the potentialities of the entire area should be prepared by Colonel Cadell, of Bo'ness and Mr. P. J. Pringle, chairman of Leith Dock Commission, and submitted to the proper quarter.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Following upon the termination of local holidays, an anticipated revival in business is being realised. Home allocations of Cleveland pig-iron for September are being issued freely, and merchants report them heavier than those for August, particularly so far as North of England foundries are concerned. With the supply of foundry iron quite plentiful, no difficulty is experienced in placing orders, and substantial sales for delivery over next month have been arranged. No attempt is made to do forward business in foundry iron, but forge quality is selling over the next few months. Though more iron is available for shipment and tonnage arrangements are better, export trade is only quiet. So far as merchant business is concerned, quantities released are on only a limited scale, but shipments to France, arranged through official channels, are understood to be on a fairly good scale. For home consumption, No. 3 Cleveland pig-iron, No. 4 foundry, and No. 4 forge all stand at 92*s.* 6*d.*, and No. 1 is 96*s.* 6*d.*; and for shipment to France and to Italy No. 3 is 102*s.* 6*d.*, No. 4 foundry 101*s.* 6*d.*, No. 4 forge 100*s.* 6*d.*, and No. 1 107*s.* 6*d.* The stock of Cleveland pig-iron in the public warrant stores still stands at 1,137 tons, all of which is No. 3 quality.

Coke.—Continued keen demand for coke for local use keeps prices at the fixed maximums, though supply is very ample. Average blast-furnace qualities are 28*s.* at the ovens, and descriptions low in phosphorus 30*s.* 6*d.* at the ovens.

Hematite Iron.—Very little new is ascertainable concerning the East Coast hematite branch of the staple industry. Conditions continue very stringent, and distribution is under rigid official supervision. Regular and adequate deliveries are going steadily forward to home customers, and every effort is made to ship to our Allies as much iron as possible against old contracts, but new business is on only a limited scale. From time to time home transactions are put through, but foreign sales are not recorded, and export quotations are nominal, traders holding off pending efforts to make certain rearrangements as regards prices for shipment abroad. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, and we understand it is suggested the export price should be fixed at 141*s.* plus the amount of excess freight agreed on for various ports.

Manufactured Iron and Steel.—No alteration or movement of importance can be reported of the various departments of finished iron and steel. Suspension of operations at works for the local holidays has enabled firms to carry out many long overdue repairs and renewals. Demand for material shows no abatement, heavy Government requirements and large and still-increasing needs of the shipyards absorbing output. Quotations are strong. To home customers the following are among the principal market rates:—Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; double best bars, 14*l.* 10*s.*; treble best bars, 14*l.* 17*s.* 6*d.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 18*l.*; packing iron and steel (parallel), 13*l.*; packing iron and steel (tapered), 15*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.* and upward; steel boiler plates, 12*l.* 10*s.*; steel strip, 15*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.*

NOTES FROM THE SOUTH-WEST.

Cardiff.—The arrival of tonnage over the week-end was not quite satisfactory, and it has been difficult to arrange stems for other than best steam coals. There is, however, just sufficient to keep the collieries at work. Chief attention at the moment centres in the allocation certificates issued under the Coal Controller's reorganisation scheme. It is reported that in many cases collieries have returned the certificates with a note that they are not in a position to supply, but the fact has to be borne in mind that the provisions of the Order are compulsory, and that collieries are under obligation to supply the coal as near as possible to the description applied for. The scheme does not come into operation till the beginning of the second week in September, but if enforced in all its details, it is feared its effects will be disastrous. It now transpires that the suggested revised list of small coal prices runs as follows:—No. 1, 21*s.* 6*d.*; No. 2, 21*s.*; No. 3, 20*s.* 6*d.*; No. 4, 20*s.*; No. 5, 19*s.* 6*d.*; No. 6, 19*s.*; No. 7, 18*s.* 6*d.*; and No. 8, 18*s.*

Newport.—The market is almost featureless. The better classes of Western Valley as well as of Eastern Valley coals are fairly supplied with tonnage, but the position of the other collieries is difficult. Smalls are weak, but pitwood is steady at the last prices, while patent fuel is ruling nominally round about 30*s.*, with, however, very little business doing.

Arrears of Coal Contracts.—The committee appointed by the coalowners and exporters of South Wales and confirmed by the Controller of Coal Mines, to deal with the question of arrears of contracts affected by the fixed-price schedule of June last, have met to discuss the position, but owing to differences of opinion on certain points not much progress was made, and the Controller has now been consulted in regard to these differences. It is stated on the coal market that the number of cases to be considered amount altogether to between 750 and 800, and that they cover arrears extending back to 1914. According to the directions of the Controller in his circular of August 2 last, the cases to be decided will be those in which the arrears are not in respect of coals already sold abroad, but a host of disputed issues have already been raised, and it is useless at the moment to hazard any view as to how these will be settled. In some cases colliery companies and purchasers have entered into arrangements to carry over arrears to next year, but these arrangements apparently will have to be ratified by the local committee before they can become effective. The view of exporters is that the committee should interfere as little as possible with such arrangements as colliery owners and their customers may find it possible to make privately, and that every consideration should be given, particularly to cases where shippers have been compelled to buy coals on the market to replace those which the Admiralty authorities have been unable to release. In some of the latter cases merchants have paid for substitute coals many shillings per ton above the price at which they were under contract with the colliery companies, and it is held to be only a matter of justice that such merchants should not be allowed to suffer because the State is nominally in control of the collieries and in possession of the coal.

Supplies of House Coal.—A circular letter has been addressed to clerks of county boroughs, boroughs and urban district councils in South Wales and Monmouthshire by Mr. Finlay A. Gibson, secretary of the District Coal and Coke Supplies Committee for that area. Mr. Gibson states that the committee have decided that as regards supplies to merchants the Welsh colliery companies shall be instructed to supply the same merchants with the same quantity, subject to certain minor reservations, in September, October, November and December of this year as was supplied in the corresponding months of 1915. The colliery companies have, however, been advised that they will be entitled to deduct from a merchant *pro rata* in each of the months indicated any quantity which they supplied to such merchants in excess of the total quantity which he was entitled to from April to August 1917, inclusive, under the terms of the scheme issued by the committee on March 30 last. This condition is made in view of the fact that many merchants obtained an increased summer supply to enable householders to stock for the coming winter. With regard to merchants who will be unable to obtain coal after September 8 from areas from which supplies into South Wales will be prohibited, the committee will be allocating to each merchant coal in substitution from collieries in Monmouthshire and South Wales.

Welsh Colliery Examiners' Strike Threat.—The lower-grade officials in the collieries in South Wales and Monmouthshire are threatening strike action in support of certain demands which they have recently formulated. These include an improved and more uniform rate of wages, and the recognition of the organisation on the part of the employers, together with the setting up of a joint board representative of colliery owners and the officials concerned. A meeting of the executive council of this organisation—the South Wales and Monmouthshire Colliery Examiners' Association—has been held to ascertain the result of the ballot taken by the members throughout the coalfield on the advisability of tendering notices on September 1 to terminate contracts with their employers on the points at issue. The report of the general secretary disclosed that an overwhelming majority had voted in favour of tendering notices, and consequently the council directed the general secretary to issue instructions to the lodge secretaries throughout the whole area that every member should tender notice on Saturday, September 1. Mr. Finlay A. Gibson, the secretary of the Monmouthshire and South Wales Coalowners' Association, dealing with the position now created, explained this week that the coalowners, as such, have no power to deal with this class of colliery employees. Firemen, he pointed out, occupy the position of colliery officials, and the customary practice has been for the companies themselves to arrange independently with firemen the terms and conditions of their employment. The companies themselves object to the Coalowners' Association intervening between them and their staffs.

CATALOGUES.

Bag Air Filters.—The Sturtevant Engineering Company, Limited, 147, Queen Victoria-street, London, send a leaflet showing apparatus for recovering dry dust from the air. The dust-laden air is drawn through fine canvas bags which are enclosed in a metal case, the dust remaining in the bags and the clean air passing upwards through the fan. The case has two compartments, one of which is in action under air draught while the filter bags in the other are being shaken clear of dust. The switching and shaking is automatic and the mechanism is intended as a component in an air-purifying system.

Sawing Machines.—The Newton Machine Tool Works, Philadelphia, U.S.A., send a catalogue of metal-sawing machines for heavy stock cutting-off. All are very heavily built, with single pulley drive and change-speed gears. The saws are circular, chiefly with inserted teeth. The work is fixed and the saw travels through the cut. Eleven sizes are listed for cutting-off round bars from 5½ in. to 22½ in. diameter, or with a special grip a number of smaller bars may be held and sawn at one cut. The saws listed run from 20 in. to 84 in. diameter. A special machine is shown cutting a 35-in. diameter billet with a circular saw 84 in. diameter.

Electric Control Panels.—Motor-control panels for alternating-current circuits for starting and controlling slip-ring induction motors are shown in a catalogue from the British Thomson-Houston Company, Limited, Rugby. These are for starting against nearly full load. No live metal parts are exposed, and over twenty sizes are tabulated, with full particulars. The same firm send a catalogue of pressure-governor panels for alternating-current or direct-current circuits for controlling pumps and air compressors. Through the action of a Bourdon tube spring the mechanism will automatically start and stop the motor from time to time, so as to maintain an air or water pressure between two fixed limits.

Brass Casting Machines.—An outfit for the rapid casting of bars is shown in a leaflet issued by the Monometer Manufacturing Company, Limited, of Aston, Birmingham. The tilting crucible is fitted with a fire jacket in which oil, either crude or heavy residual, is burned. In front is a turntable carrying ten moulds, each of which is stopped under a funnel, into which the crucible spout pours the molten metal. Three men working double shift at two of these machines are able to cast 24,000 lb. of brass bars in 24 hours, the bars being 2½ in. diameter and 40 in. long. The crucible is balanced for tilting and hand-wheel gear is fitted for working both crucible and turntable. The crucibles will endure about 65 meltings.

Graphite Electrodes.—Electrodes in the form of rods, tubes, plates, &c., for use in electro-thermic processes are described in a catalogue received from the Cromil Engineering Company, Limited, Milburn House, Newcastle-on-Tyne. The material is prepared by the Acheson Graphite Company, Niagara Falls, U.S.A. Finely-ground graphite mixed with pitch or tar is made into the required form and then treated in electric furnaces, the binding agent being first carbonised and then the whole heat-treated up to 7,500 deg. F., till practically all elements except the graphite are vaporised. The resulting material is a very pure graphite, which can be drilled, turned or planed quite easily and also threaded with the usual taps and dies. Rods jointed with spigot and socket-screwed ends are in use up to 8 in. diameter, conducting 5,000 amperes without appreciable heating at the joints. The material is used for moulds, crucibles, rheostats, contacts and fittings such as bushes, washers and discs. It may also be used up to 9 in. diameter for pipes, with screw joints for introducing or withdrawing gases at very high temperatures.

INTERNAL-COMBUSTION FARM DRAINAGE MACHINES.

CONSTRUCTED BY THE PAWLING AND HARNISCHFEGER COMPANY, MILWAUKEE.

(*For Description, see Page* 237.)

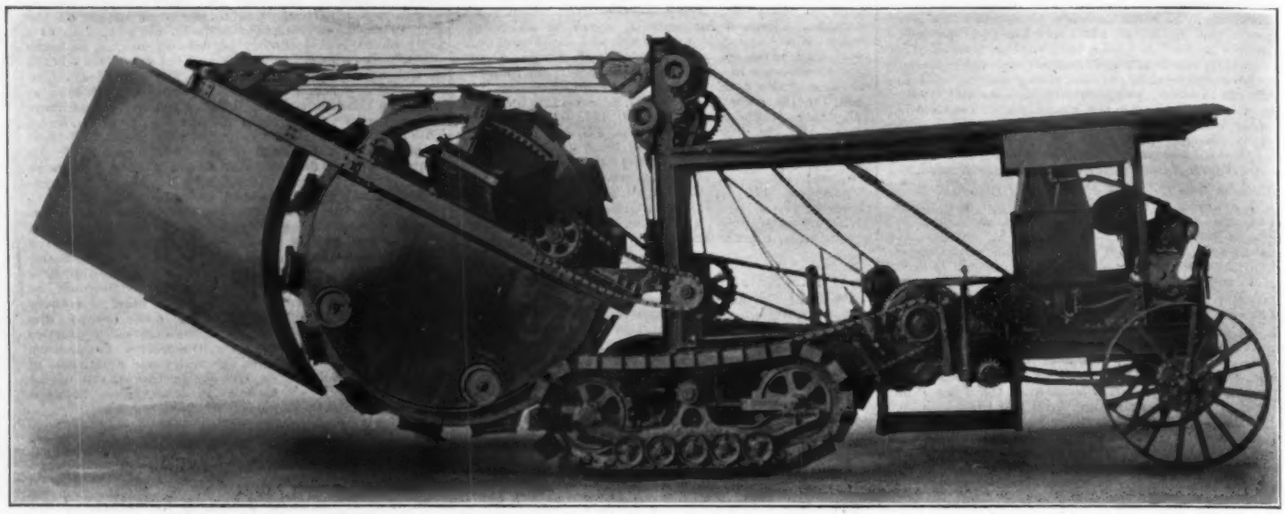


Fig. 1.

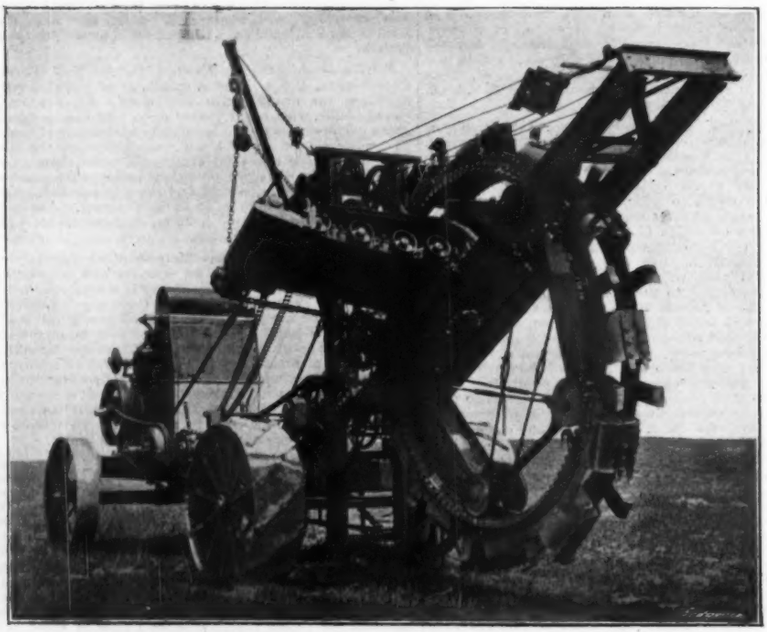


Fig. 2.

Fig. 3.

Iron and Steel Institute.—The autumn meeting of the Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, September 20 and 21, 1917, commencing at 10.30 a.m. on the 20th and at 10 a.m. on the 21st. Papers Nos. 1, 4, 5, 9, 2 will be considered, as far as time permits, the first day, and Nos. 10, 7, 6, 3, 8 the second day. The following is the list of papers that are expected to be submitted for reading and discussion:—(1) G. Barrett and T. B. Rogerson, "Present Practice in Briquetting of Iron Ores"; (2) W. J. Brooke and F. F. Hunting, "Microstructure of Commercially Pure Iron between Ar_3 and Ar_2"; (3) E. D. Campbell and W. C. Dowd, "The Influence of Heat Treatment on the Electrical and Thermal Resistivity and Thermo-electric Potential of some Steels"; (4) G. Charpy and A. Cornu-Thenard, "New Impact Testing Experiments"; (5) J. E. Hurst, "Heat Treatment of Grey Cast-Iron"; (6) E. F. Law, "Effect of Mass on Heat Treatment"; (7) T. D. Morgans and F. Rogers, "Investigation upon a Cast of Acid Open-hearth Steel"; (8) F. Rogers, "The Acid Open-hearth Process"; (9) J. H. Whiteley, "The Eggertz Test for Combined Carbon in Steel"; (10) E. B. Wolff, "Failure of Boiler Plates in Service and Investigation of Stresses occurring in Riveted Joints."

Railways in China.—An order has recently been placed with American mills, says *The London and China Telegraph*, for rails and fittings for the 20-mile extension of the Sunning Railway, which has been in contemplation for some time. The Sunning Railway is that constructed by Chinese-American capital, under the presidency and control of Mr. Chin Gee Hee. The company has constructed about 80 miles of road connecting Kongmun, a city on tidewater, with Sunning city, and on to the vicinity of Canton. The extension of 20 miles planned is to the west of Sunning city to Pak Sha, and eventually is to extend south to the seaboard at Yeung Kong. It is further planned to extend the road westward from Yeung Kong into Kwangsi Province, with the idea of tapping the Pak Hoi district and connecting that part of the province with Hong-Kong. For the present, however, construction is to be undertaken only to the sea. The railway is a good example of what may be accomplished by intelligent railway work in China. The concern was started with comparatively small capital, and most of its line and equipment have been paid for out of the earnings of the parts of the line already in service. This has been the case with the new extension. The total earnings of the road in 1914 were a little over 630,000 dols., local currency. In 1915 the earnings were something over 830,000 dols., and in the past year they amounted to 1,051,000 dols. The net profits for the past year have been about 510,000 dols. An order has also just been placed for new American locomotives for the railway. During the past year considerable improvements have been made in the stations and yard equipment of the road, and in other respects it is gradually developing into a road with very satisfactory equipment.

THE GEM LAKE AND AGNEW LAKE DAMS, R

MR. L. R. JORGENSEN, AM

(For Descripti

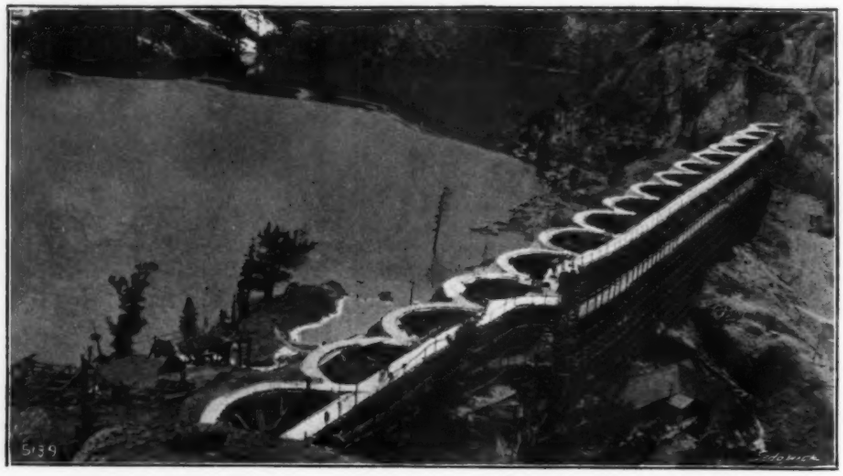


Fig. 11. Gem Lake Dam, showing Runways and Concrete Elevator.

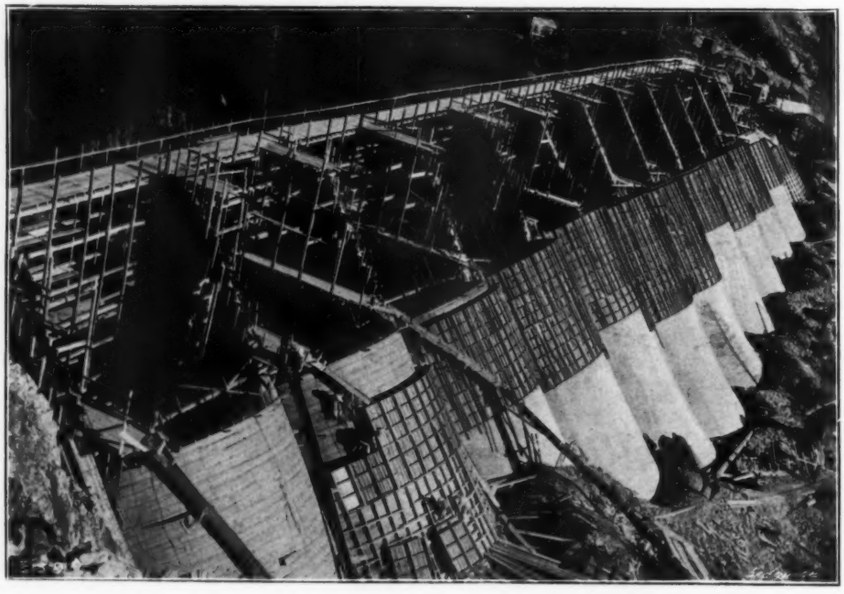


Fig. 12. Gem Lake Dam, showing Section of Up-Stream Form being Hoisted into Place. Also Main Upper Runway with Branches along Buttresses.

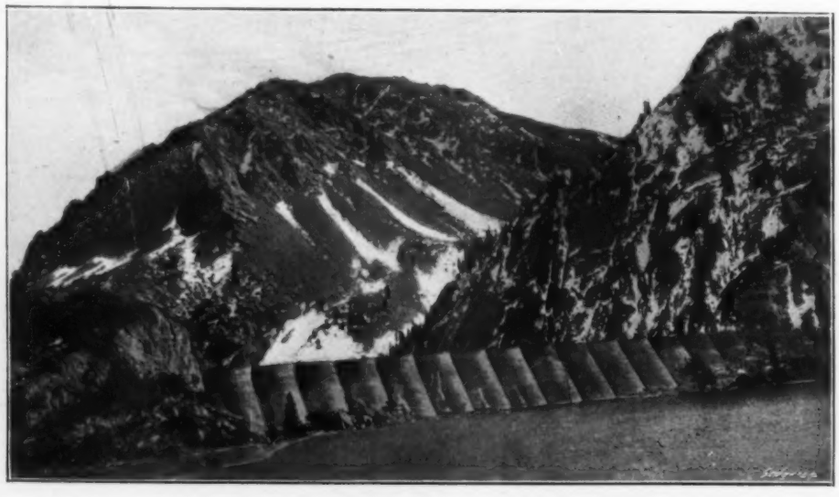


Fig. 13. Gem Lake Dam with Water Level 35 Ft. above Tunnel Floor.

Fig 14. Gem Lake D, s
Form ILDI

Fig. 15. Applying P
with

AMS, RUSH CREEK, MONO COUNTY, CALIFORNIA.

GENSEN, AM.SOC.C.E., ENGINEER.

r Descrip see Page 224.)

EM LAKE D SHOWING PROGRESS OF FORM ILDING.

PPLYING P ER TO UP-STREAM FACE WITH T GUN.

FIG. 16. UP-STREAM FACE OF AGNEW LAKE DAM.

FIG. 17. DOWN-STREAM FACE OF AGNEW LAKE DAM

FIG. 18. DOWN-STREAM FACE OF AGNEW LAKE DAM, SHOWING SINGLE STRUT AND BUTTRESSES, AND ALSO COPING ALONG CREST OF ARCH.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Turner and Henderson, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia, Melville and Mullen, Melbourne, Victoria.
CANADA, Toronto, Ont.: Wm. Dawson and Sons, Manning Chambers. Montreal: Sells, Limited, 303, Shaughnessy Building, McGill-street.
EDINBURGH: John Menzies and Co., 12 Hanover-street.
FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Subscriptions and Advertisements, Librarie B. Tignol, 53bis, Quai des Grands-Augustins, Paris. Also for Advertisements, Agence Havas, 8, Place de la Bourse.
GLASGOW: William Love.
INDIA, Calcutta: Thacker, Spink and Co. Bombay: Thacker and Co., Limited.
ITALY: U. Hoepli, Milan, and any post-office.
LIVERPOOL: Mrs. Taylor, Landing Stages.
MANCHESTER: John Heywood, 143, Deansgate.
NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.
NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.
ROTTERDAM: H. A. Kramer and Son.
SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elisabeth, Bloemfontein, Durban, and their various branches and bookstalls throughout South Africa. Also Cape Town: Wm. Dawson and Sons, 31, Longstreet.
TASMANIA: Gordon and Gotch Proprietary, Limited, Launceston: Hobart.
UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. Chicago: H. V. Holmes, 967-968, Monadnock Block.
For Advertisements, J. S. Allan, 503, Stratford Avenue, Bridgeport, Conn., U.S.A.

ADVERTISEMENT RATES.

The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£2 4 6
For Canada—	
Thin paper copies	£2 0 6
Thick " "	£2 5 0
For all other places abroad—	
Thin paper copies	£2 5 0
Thick " "	£2 9 6

When foreign subscriptions are sent by Post-Office Orders, advice should be sent to the Publisher.
Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.
All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C. 2.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3603 and 8596 GERRARD.

CONTENTS.

	PAGE
The Restriction of our Coal Exports and its Effect upon the Gas Industries of the World	217
Industrial Councils and the Garton Memorandum.—No. III	218
Making Machinable Castings from Permanent Iron Moulds (*Illus.*)	219
Treble-Geared Boring and Facing Lathe (*Illus.*)	221
Nail Die Grinding Machine (*Illus.*)	221
The Order of the British Empire	222
Molybdenum and Ferro-Molybdenum	222
Multiple-Arch Dams on Rush Creek, California (*Illus.*)	224
Properties of Gasoline	225
A Method of Averaging (*Illus.*)	226
Wanted: A National Association of Engineering Foremen	226
Naval Honours and Decorations	226
Notes from South Yorkshire	226
Notes from the North	227
Notes from Cleveland and the Northern Counties	227
Notes from the South-West	227
Catalogues	227
The Report of the Committee for Scientific and Industrial Research	229
Labour in Germany during the War	230
Tungsten Filaments	232
The Carbonisation of Coal (*Illus.*)	232
Notes	233
Literature	234
Books Received	235
Industrial Notes	236
Internal-Combustion Farm Drainage Machine (*Illus.*)	237
Boiler Explosion at Bathgate	238
ENGINEERING Patent Record (*Illus.*)	239

With a Two-Page Plate of the GEM LAKE AND AGNEW LAKE DAMS, RUSH CREEK, MONO COUNTY, CALIFORNIA.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, AUGUST 31, 1917.

THE REPORT OF THE COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

THE second annual report of the proceedings of the Privy Council Committee for Scientific and Industrial Research, including the detailed report of its Advisory Council, makes comfortable reading in these troubled and unsettled times. It is the record of an undertaking begun in the turmoil of war under the stress of military needs, yet carried on up to now with a steady and consistent policy which would have been creditable to a well-established department in times of peace. It tells of anticipations verified by the event, and of even more hopeful expectations to be realised in future working. Among State papers, of which lately very many have had to emphasise the country's difficulties, it stands almost alone in its message of assured confidence and encouragement. The department for which the report speaks was formed to translate into action the clear convictions of its originators as to the place of research in modern industry. These convictions remain unchanged, and seem, happily, to have kept their original strength and clearness, undisturbed by the political eddies and undercurrents that are frustrating so much else of the country's most urgent and most sacred purposes. They are guiding the department in a steady course through the many difficulties and conflicting interests with which it has to deal; and the most earnest wish of those who read its present report with the interest and attention that it deserves will be that it may continue to have the unswerving courage of the convictions that have carried it so far, and to avoid being drawn into entanglements by which it might be diverted from its proper object.

Engineering is the servant of most industries, and the report is not the less important to engineers because much of it is concerned with the interests of its customers. Those who do not read it in the original will, therefore, be likely to prefer a summary in the original perspective to one confined to strictly engineering topics. Nor, indeed, will such a summary be much bulkier than one of a more restricted scope; for, as is natural at the present stage of the department's development, the report is devoted even more to the principles on which the department is approaching the problem of industrial research, principles which are much the same for all industries, than to the enumeration of the individual researches that have been undertaken.

The report of the Advisory Council is divided into two parts, of which the first may be regarded broadly as dealing with systematic measures, and the second with sporadic researches and topics.

The most important result of the year's work has been that the department has arrived at a definite policy in respect to co-operative research. In the Council's view, few of the trade associations which of late have been freely formed, even though they include research among their objects, satisfy the conditions necessary for receiving the full help of the State. Without tying possible founders of research associations to the details set out in the report and its appended forms, the Council has now arrived at a clear conception of the type of association that is required. After consultation with a large number of leading manufacturers and business men it has drafted and gives in an appendix a model memorandum and skeleton articles of association for companies limited by guarantee of nominal amount, and not trading for profit, together with a description of the manner in which such associations are expected to work, and a statement of the conditions under which the department can co-operate with them. The principle underlying these documents is that no Government administration, however efficient—and the remark may be extended with equal force to the administration of trade associations—can replace the independence and initiative of the individual manufacturer, to which British industry has owed so much in the past. State aid must therefore be so given that its effect will be rather to increase than to decrease that independence and initiative; and where the State co-operates in research with a trade association, it must be on terms that allow the research to be made and applied under the direct control of the industry itself.

This co-operation is to be provided by forming either in an industry or in a section of it an association of manufacturers for co-operative research, the department adding to the funds of the association an amount which will vary with circumstances, but will very rarely exceed the association's own assured income from other sources. Such an association will be concerned primarily with research peculiar to the trade or section to which its members belong, but with regard to questions of common interest to more than one trade or section it is intended that the associations concerned shall themselves work co-operatively.

In return for their subscriptions it is expected that members will have a service of summarised technical information relating to the industry, both at home and abroad, and the right to any technical information within the scope of the association or the allied group of associations; the benefit, in common with other members, of the results of any researches made by the association on the suggestion of any member and with the approval of the association's Committee or Board; the right to use any patents or secret processes resulting from such researches, either without payment or on terms that would be nominal compared with the charge to non-members, and the right to have approved researches made at cost price for their own individual benefit. All these advantages are to be reserved exclusively for members; and in return for them each constituent firm will subscribe to the association an amount proportionate to its individual size, though its enjoyment of the benefits will not be similarly limited, except in so far as its own weaker financial position may restrict its ability to exploit the results of the association's researches.

The State contributions made under these arrangements will be spread over an agreed term, not more than five years, except in special circumstances; and it is hoped that by the end of that time the association will be able and prepared to carry on its work without any State aid. To give the Council a fair start, enabling it, so far as funds are concerned, to make sure that researches will be carried through when they have once been started, the Committee, as already announced, has secured from the Government a sum of 1,000,000*l.*, vested in a body of Ministers who are themselves *ex officio* members of the Committee, who will also hold gifts from other sources for the same purpose, such, for instance, as one that has already been received; and this sum is to be spent over the next five or six years.

Contributions made to associations co-operating with the department will, for the purposes of income tax and excess profits, be reckoned as working expenses, thus making them a particularly attractive investment for firms who would otherwise be suffering severely from those taxes. The draft memorandum of association defines the association's objects in wide terms, covering equally a laboratory research and a full-scale manufacture. By the skeleton articles the department reserves to itself the approval of the articles and initial *personnel*

of the association, and decides appeals from members whose individual interests may be threatened by proposed researches, as well as the extent to which the publication of results should be limited in the national interest. It is asked that as far as possible the board of management should include representatives of capital, management, science and skilled labour in suitable proportions, and that a director of research should be appointed. By the conditions of grant the Council has also the approval in each year of the scheme of research and its budget of the expenditure on buildings or permanent equipment beyond a fixed sum, and of the terms on which work may be done by the association for individual members. It may also, after consultation with the board of the association and other co-operating bodies and persons, decide whether the results of a research shall be patented or otherwise protected, in what proportions the ownership of the resulting rights shall be divided between the council and the various co-operating bodies, and what reward is to be paid to an employee who makes a discovery or invention in the course of the research, all such discoveries being the property of the association on the terms of agreements to be approved by the Council. The proposed inclusion of representatives of labour in the managing body is interesting, as in the form suggested it would apparently be free from the objections that apply to proposals in which the interests of an industry would be controlled by an equipoise between classes; and the share of the direction here suggested for labour would be of real value, both in what its representatives would teach their colleagues and in what they would learn.

The first of the proposed trade associations will cover all sections of the cotton industry, from spinners to dyers, printers and finishers, and will undertake research extending from the study of the cotton plant to the finishing of goods. Its structure and details have been worked out by a Provisional Committee, which has met at fortnightly intervals for nearly twelve months, and by additions from time to time to its membership has become representative of the entire trade. Its memorandum and articles are now in draft, and it is hoped that the association will be established within the next few weeks. Pending its formation, various researches in prospect have been held up, with the interesting exception of a research on Sea Island cotton actually in progress, to which, by arrangement with the Government of the island of St. Vincent, the department has given help required to enable the work to be continued without interruption and to greater advantage. In due course this research is to be taken over by the new Cotton Research Association. Steps to form similar associations have now been taken by the woollen and worsted manufacturers of Great Britain, the Irish flax spinners and weavers, the Scottish shale oil industry and the photographic manufacturers. The electrical engineering firms and the British Society of Aircraft Constructors, in conjunction with the Aeronautical Society, have the matter under consideration; the Scottish shipbuilding and steel industries are moving; and hopes are entertained of the formation of an association for research into the non-ferrous alloys in the near future. The British iron puddlers and the Diesel engine manufacturers are understood to have established independent research associations. The department has been approached by the piano manufacturers, master printers, and cocoa manufacturers, and it is hoped that the list will grow as the sense of the value of research to the several industries extends throughout each trade. At present cases, such as that of paper makers, are not uncommon in which leading members of a trade have acquired this sense, and are urging the department to establish, for trade purposes, a State laboratory, to the cost and maintenance of which they are anxious to contribute, but as yet have not been able to carry the rest of the trade with them. Some trades, such as the pottery and glass industries, have been driven to co-operate in research through sheer necessity; others, such as the chemical trades, have grown into single combinations so huge that they are relatively independent of co-operative working. Between these two extremes are many industries, some of them rich, which, as the report drily remarks, "appear to be uncertain in which direction to move, and would probably prefer to move in neither."

There are, however, important fields of research which, though of intimate consequence to a variety of industries, are too much everyone's business to be suitable for co-operative research by even a combination of trade associations. Fuel is a case in point, which has been met by the institution of the Fuel Board, already fully described in these columns. Timber, fire-resistance of materials, cold storage, illuminating engineering, are examples of other fields for research which are in varying degrees unsuitable for any except national treatment, and the Council will, in due course, be dealing with them. In the meantime it has recognised as a class of problem equally insusceptible to treatment by research associations the determination of constants and the accurate testing of manufactured products, work of which the range and importance are certain to grow rapidly. It has therefore taken the important step of taking over the financial responsibility for the maintenance of the National Physical Laboratory, the scientific management remaining unchanged, and Lord Rayleigh, the vice-chairman of its executive committee and a member of the Advisory Council, remaining as a connecting-link between the two bodies.

An account has been given from time to time of most of the individual researches that are in hand, now 44 in number, in addition to work done by 36 individual research workers with the help of grants. For these reference must be made to the original report; but the co-operation which has led to the formation of a national Institute of Technical Optics may be quoted as a good instance of co-ordinated effort. Here the London County Council contribute 1,000*l.* a year for maintenance and a capital sum of 2,500*l.* for alterations and equipment, the Research Department make a grant of 750*l.* for special apparatus and 1,000*l.* a year for five years for maintenance, the Governors of the Imperial College (where the new Department of Technical Optics has been instituted) give the necessary accommodation and a grant of 2,000*l.* for equipment, and the optical instrument makers of London have already contributed apparatus to the value of over 1,000*l.* The new department is fused with the existing department for the same subject at the Northampton Institute, and the board of management is under the chairmanship of Mr. Acland, a member of the Advisory Council. The work is being further assisted by the translation into English of the standard works of von Rohr, Gleichen, and Ferraris on optical instruments.

Of more general interest are the surveys that are being undertaken of the fields for research, first steps in which were the reports on coal and on ore resources. Similar surveys are to be prepared on smelting and refining copper, and the qualities of copper and copper alloys. The committee to which these surveys have been entrusted, representing the Institute of Mining and Metallurgy, the Institute of Metals, the Engineering Standards Committee, and the trades concerned, is also to undertake the direction of a research into methods of producing sound copper and brass castings, pending the formation of a non-ferrous alloys research association. A survey, with bibliography, is also to be prepared on the field of research in lubrication and lubricants, and a grant has been offered towards the cost of a similar survey of the field for research into the flow of steam in pipes. The department is now beginning to issue bulletins, the first of which is a memorandum on the decay of timber in coal mines; and it has published the first number of a series called "Science and Industry" (Mr. Fleming's account of American research facilities), which, when times allow, will be followed by others on problems of training, organisation and procedure.

Parallel developments are going on in Canada, Australia and South Africa; and the first overseas research initiated by the department is being carried out in India on the black dyeing of tussore silk.

Other topics are included in the report, all of interest to industry, and some, such as the provisions for protecting inventors, particularly so to engineers; but we have said enough to indicate the serious importance of the Committee's work, that the department is continuing its work as the best interests of industry demand, and we hope that this account of it may induce many of our readers to refer for themselves to the original report.

LABOUR IN GERMANY DURING THE WAR.

The war has wrought many and great changes in the conditions of German labour, changes which will no doubt make themselves felt long after the restoration of peace. Its influence has been felt in almost every direction, in the organisations, the aspirations, and the position generally of the employees. The emergencies of war have enhanced the value and importance of labour in Germany, as elsewhere, and although the labour organisations show a material reduction in their number of members, their standing and influence, on the other hand, have improved and increased during the last three years.

Some figures will illustrate the manner in which the war and its consequences have reduced the ranks of the trade unions. The decrease in the number of members is in many cases very serious, due to calls to the front and other reasons. The Metal Workers' Union, before the war, boasted considerably more than 500,000 members, but after a year and a half of conflict the number had receded to about 234,000. The reduction in the final aggregate is accounted for by the calls to the colours which, in 1914, amounted to about 185,000 members, and during the next year to 117,000. A large number of members, about 80,000, left the union for other causes during 1915, but this was more than made up for by the entrance of new members, of which, however, some 19,000 were women, although the number of new female members has by no means, it is stated, kept pace with the increase of female hands in the industry. The Building Trades Union has had a still greater loss in its numbers, and has probably suffered more than any other. In 1914 the members of this union were about 236,000, belonging to 888 local branches; in 1915 the average figures had receded to respectively 101,000 and 847, and by the end of the year the number had further dwindled to about 83,000 members. The "Free" Trade Union in Berlin comprised, at the beginning of 1914, 302,000 members; at the end of the following year only about 144,000. No doubt the cessation of war will mend this state of affairs to a very material extent.

On their return to their former work the men from the front will find the position of their unions not a little altered, and that for the better as far as influence and other conditions are concerned. Their legal footing is likely to be further improved, when the new era in Germany begins to materialise and more liberal views are allowed to prevail. In the meantime the Government has on several occasions deigned to accept the good services of the trade unions in some more or less difficult questions, and this alone marks a new departure. The German labour organisations have hitherto been somewhat unfavourably situated in their actual legal position, and a reform of the right of coalition in a more liberal spirit has also been called for in advanced sections. It has in this connection been remarked that, as matters stood, the freedom of coalition was legally acknowledged, but with the important reservation that the agreements which ensue from it, in principle, lack any legal protection. The trade unions have been unable to register their unions, as they come under the exception constituted by unions with political and social-political aims. As regards the future of trade unions and other labour organisations, much, of course, will depend upon the position taken up by the men themselves. Politically there are serious divergencies among the social democrats of Germany, and should too radical or extreme views gain the upper hand and be expressed sufficiently openly, this might impede the concessions which the Government otherwise may be disposed or find it expedient, or even necessary, to grant to more moderately minded bodies.

Germany excels in exact and recent statistics, but the war has interfered with these, and as regards the movement of wages, for instance, the material available is by no means satisfactory. Wages in the different industrial branches have, of course, been very unevenly affected; in some they have receded from the average of the last peace year, 1913, which was a very satisfactory year on the whole for German industries. In more, however, they have advanced, and that very substantially in some branches. Amongst the more comprehensive official statistics bearing upon the wages movements are those dealing with the accident insurance of the *Berufsgenossenschaften*, which, however, do not particularise, but only afford the information on a broad basis, in the shape of annual average earnings for adult hands in each *Berufsgenossenschaft*. Omitting the year 1914, as one both of peace and war, it appears that the average annual earnings for an adult hand were higher in 1915 than in 1913 for 45 *Berufsgenossenschaften*, with close upon 5,000,000 hands, and lower in 21, with rather more than 2,000,000 hands. That the rise within the first group varied considerably will appear from the fact that it was only 0.3 per cent. for the South-West German Iron and Steel Union, and 23.9 per cent. for the Bavarian Building Trades Union, whilst the reduction ranged between 0.4 per cent. for the Hanoverian Building Trades Union and 24.2 per cent. for the Alsace-Lorraine Textile Trades Union. The following table contains some further particulars of the movement:—

	Per Cent. Higher.
North-Eastern Iron and Steel Trades Union	21.6
Leather Industry	18.1
Thuringian Building	13.9
Iron Works and Rolling Mills... ...	12.7
North German Metal	12.7
Machine and Small Iron Industry ...	11.3
North-Eastern Building	10.9
North-Western Iron and Steel ...	10.4
	Per Cent. Lower.
South German Textile	18.8
Saxonian Textile	10.4
Hesse-Nassau Building	14.3
Clothing	13.6

The highest annual wage is found in the Iron Works and Rolling Mill Union, at 1,961 marks per annum; the lowest in the Alsace-Lorraine Textile Union, at 617 marks.

Also the wage statistics in some sick funds throw a light, although indirectly, on the alteration in wages. If the wages rise, without any increase taking place in the membership, the number of higher-paid classes must increase and the lower decrease. If, with a general rise in wages, many youths and unskilled hands seek and get employment, the proportion of the lower classes will increase, the upper either increase or remain stationary, or in any case decrease at a slower rate than the medium classes, which have been passed by the upper and not yet reached by the lower classes. In the males insured in the Berlin General Sick Fund the number in the three lowest-paid classes (up to 3.15 marks per day), increased from January to December, 1916, more especially the lowest class (up to 1.15 marks per day) which rose from 10.2 per cent. to 12.4 per cent. The number in the three upper classes, on the other hand, has almost continuously decreased. This was more especially the case with tradesmen's apprentices, or youths, of whom the percentage in the three lower classes rose from 21.9 per cent. to 30.5 per cent., whilst the upper classes showed a general decrease. The opposite was the case with the males insured in the machinery, instruments and apparatus industry. The number in the better paid classes (above 5.15 marks earnings per diem) rose from 43 per cent. to 46.1 per cent., that in the medium classes (from 3.16 marks to 5.15 marks daily wage) declined, as did also those with daily earnings of from 1.16 to 2.15 marks, whilst those in the lowest-paid classes (up to 1.15 mark per day) rose from 17.5 per cent. to 19 per cent. That is the typical wage and employment movement in the war industry proper. Also as far as the female hands are concerned there is a rise in wages, though less pronounced than for the men.

The figures are more favourable for the Leipsic Sick Fund, because the membership comprises a larger proportion of hands employed in war industry proper (the metal and machine industry) and other industries with high wages (building and printing industries). In the aggregate of male hands of the better-paid classes (above 5.50 marks per day) the percentage, from January to December, 1916, rose from 45.2 per cent. to 47.6 per cent. The classes between 4 marks and 5.50 marks have decreased, and most so that with earnings from 5–5.50 marks. The classes from 3.50–4 marks have somewhat increased, as well as those from 2.50–3.25 marks, but these classes form but a somewhat insignificant proportion of the aggregate. The number of youths and apprentices which form a separate class rose from 10.8 per cent. to 16.8 per cent. In the machine industry the proportion of the highest class rose from 52 per cent. to 63 per cent., in the building trade from 58.3 per cent. to 62.2 per cent. In the textile industry, on the other hand, the proportion fell from 40.1 per cent. to 28.2 per cent. As regards the female hands the same conditions prevailed as in Berlin.

Apart from the two sources referred to above there are official statistics concerning wages in the mining industry, with reference to which the following table contains some particulars. The figures represent the average wages:—

Coal.	1913.	1915.	Third Quarter 1916.
	Marks.	Marks.	Marks.
Miners proper, underground or surface work in Dortmund district	6.47	6.84	8.50
The same class in Upper Silesia ..	4.85	5.47	6.85
Hands employed above ground (exclusive of women and juvenile hands) in the Dortmund district	4.34	4.65	5.38
The same class in Upper Silesia ..	3.19	3.59	4.26
Lignite—			
Miners proper, underground, in Halle district	4.51	4.81	5.48
Ore Mining—			
Miners proper in Mansfeld district	3.90	4.73	6.40
Hands employed above ground (exclusive of youths and women) in Mansfeld district	3.57	3.98	5.29

It will be seen from the above that since 1913 the lower wages have risen more than the higher, in some cases as much as 50 per cent., whereby the difference between the various districts in Germany, which formerly was very marked, has been diminished. The same movement may be noticed in other cases during the war in the matter of agreements, inasmuch as the lower wages are raised much more than the higher, greatly, no doubt, owing to the increased cost of living. As an example the hat makers may be mentioned; according to an agreement arrived at in August, 1916, hands earning 12 marks a week had an increase of 20 per cent., those earning 40 marks only one of 3 per cent. For the wood-workers the lowest pay per hour was raised from 34 pfennigs to 65 pfennigs (7½*d.*), the highest from 67 pfennigs to 85 pfennigs (10½*d.*). It is, however, difficult to arrive at accurate results, because the wages fixed in the various agreements as a rule are minimum wages, which are exceeded in practice. Thus the organ of the wood-workers, commenting upon an offer from the masters to give an increase upon the last peace tariff of 25 per cent. all round, pointed out that this was only, so to speak, throwing dust in the eyes of the men, as wages already had practically risen 25 per cent. above the level of the tariff.

The increases in wages during the war, as regards the trade unions, are not of much importance, and have in many cases been exceeded in practice. The statistics available are altogether incomplete. Two deductions, however, can be made from the available material, viz., in the first place, that wages all round have risen considerably for male labour and less so for female labour, due to the increased cost of living and the shortage of hands; secondly, the very substantial profits which many industries have earned during the war do not seem to have influenced the wages in those industries to any marked degree. In this connection Germany would seem to differ distinctly from America, where stupendous wages have been earned in the industries specially engaged in manufacture for war purposes, and also, though perhaps somewhat less so, from England. As far as Germany is concerned the average rise in wages during the war may confidently be stated not to exceed the increased cost of living; on the contrary, wages have in many cases, perhaps in most, not kept pace with the rise in price of the necessaries of life.

It is almost to be wondered at that wages have not risen higher in the branches engaged in the manufacture of munitions, for the masters, in order to secure the necessary number of hands, frequently offered higher wages than their neighbours, and the men in consequence often moved from one place to another to better themselves. The employers' organisations in several instances tried to put a stop to these unsatisfactory conditions, but in many cases without much avail, as they could not control outside firms. In some industries the masters called for and obtained aid from the military authorities, who in Berlin, for instance, issued a manifesto urging employers who had military contracts not to engage hands previously employed in similar military work, unless they could produce a certificate from their former employer that they had left him with his consent. The men objected to this "infringement" of their freedom, but, at the same time, failed to make full use of their opportunities.

Otherwise labour conflicts showed a marked decrease, more especially, perhaps, during the earlier portion of the war, which was only natural. Thus during the last five years preceding 1914 the average number of labour stoppages per year amounted to 2,595, affecting an average of some 327,000 hands. During 1914 the figures receded to 1,223 and 95,000 respectively, and of stoppages of labour only 24 date from the time after the declaration of war. Also 1915 showed very moderate figures, the number of strikes only amounting to 137, affecting 178 concerns and comprising 47,000 hands. Last year, on the other hand, showed a very marked increase; the number of strikes amounted to 239, the concerns affected to 436, and the number of hands to as many as 420,000. This is attributed to several causes: in the first place large groups of men undertook strikes to take advantage of the unusually favourable conditions, and, secondly, the vast number of well-disciplined hands which were called to the front had been replaced by less organised and perhaps less docile workpeople, amongst whom women are to be found in a much larger proportion than formerly. During the current year there have been some very extensive strikes, but on the whole they have been of comparatively short duration, and they have in many cases had special objects in view of the nature of peace or food demonstrations. Of special importance was the strike last April of the hands employed in the metal and the wood-working industries and the transport trade, which strike apparently originated from the reduction of the bread rations, but was complicated by the calling to the front of a member of the Metal Workers' Union under some special circumstances which irritated the men. The central board of the trade unions disapproved of the strike, and after some negotiations the matter was compromised and work resumed within a few days. The military authorities viewed this and other stoppages of work with stern displeasure, and very stringent decrees were issued from time to time.

Immediately war broke out the labour market became entirely demoralised, and the number of unemployed hands was very great. The social-democratic trade unions (or *Gewerkschaften*) then comprised some 2,500,000 organised hands. Of these 27.7 per cent. were called to the front in the month of September, 1914, and of those remaining at home 21.2 per cent. were out of work, against 5.9 per cent. unemployed in the English trade unions the same month. This state of affairs soon altered in Germany, and the idleness of voluntary unemployed and other "slackers" was put a stop to by the *Vaterlandischen Hilfdienst* on December 5, 1916. This measure made work in the service of the Fatherland compulsory for every man between his completed 17th and 60th year, and its regulations are not to be trifled with. Amongst other things it was no doubt meant to put a stop to

or in any case placed very serious obstacles in the way of, the men's liberty to move from one place of employment to another without any reasonable cause.

In its passage through the *Reichstag* the labour organisations, however, succeeded in inserting several important amendments which afforded distinct advantages to the men. Thus the appointment of workmen's committees in large concerns, for which the men had fought in vain for years, was conceded in connection with all concerns whose work came under the designation of *Hilfdienst* for the Fatherland, and where as a rule not less than 50 hands were employed. These permanent workmen's committees have been instituted for the advancement of good relations between the men themselves and between the men and their employers, and these committees have the legal right to bring their wishes before their employers. Further, mediation and arbitration institutions have been instituted for dealing with disputes about wages and other labour conditions. These arbitration awards are not absolutely binding upon the parties concerned, but if the employer does not abide by the award the men have the right to demand the certificates which entitle them to leave the works. If, on the other hand, the men do not act upon the award they are not entitled to any certificate on the basis of the matter with which the award deals.

This sweeping measure has not been received with unmixed approval by either side. Thus it has caused a considerable amount of discord amongst the men themselves, inasmuch as the different labour organisations have taken divergent views. The social-democratic, the "free" trade unions (*Gewerkschaften*), the Hirsch-Döcker *Gewerkvereine* and the "Christian" trade union are unwilling to acknowledge the representatives chosen by the so-called "yellow trade unions," which the employers favour, as real workmen representatives; they even maintain that they only figure in the committees as representatives for the employers. The certificate of leave regulation has also caused some trouble and met with the disapproval of the men. Masters were indisposed to engage a man without any such certificate, for if he came from a concern within the domain of the *Hilfdienst* (which was not always easy to find out) the master made himself liable to punishment if he engaged him. The result was that the men occasionally had to go idle for some time. To remedy this drawback the regulation was introduced that when an employer declined to issue a certificate of leave, he was bound in the meantime to continue to find employment for the man in question on terms not inferior to the old ones. On the other hand the man, in his turn, was bound to go on working till the matter had been duly gone into.

The masters view with apprehension clause 9 in the Act, which gives as an important reason for the men to leave their place "a suitable improvement in the conditions of work." Falling back upon this clause, the men often claim a substantial rise in wages as an "important" reason for seeking another place of employment. This clause, however, also lends itself to undesirable use by the employers. The shortage of labour, more especially in the busiest war industries, has induced masters to advertise for hands. This, in a way, means trying to get men away from their present employers at a somewhat higher wage; the applicant for labour supplies the necessary certificates to the men who have responded to his advertisement that they can there obtain "an improvement of the work conditions" by an increased pay, and the result is considerable instability in labour. The men change their place of employment as never before—and that by means of the *Hilfdienst* Act, which was intended to have the opposite effect. The efforts made by the employers' unions, in some cases aided by the authorities, have so far proved of but small avail.

It will be of much interest to witness the further developments in German labour and its organisations. If the men were more united they would apparently have better opportunities now than at any previous period of improving, extending and consolidating the rights and the scope of their organisations. But the divergencies which, of late, have been made manifest within their ranks are not unlikely to jeopardise their chances.

The position of German labour and German industries after the war has for a long time attracted the greatest attention within the country, and the manner in which the military demobilisation and the industrial remobilisation is to be brought about is being considered by a special Parliamentary Committee. The demobilisation, of course, will have to take place by degrees, but no man is to be sent home, at least not during the first four months, who has not found employment. The oldest men will be sent home first, and special regard will be shown to fathers of families. So as to provide the best conditions for work in the different walks of life, the return of the men will take place with special consideration to the following classes:—

(*a*) Prominent persons within the domains of commerce, industry, shipping, &c.

(*b*) Leaders of commercial, industrial and agricultural undertakings and their officials, such as engineers, foremen, inspectors, &c.

(*c*) Independent artisans, farmers, &c.

(*d*) Officials in the service of the State, the provinces and the municipalities, clergymen, teachers, State railway, private railway and tramway officials.

(*e*) Seamen and fishermen.

(*f*) Skilled hands, provided they at once can obtain fixed employment.

(*g*) Unskilled hands in such branches where there at once will be a strong demand for labour, for instance in the mining industry, farming, the overseas traffic, harbour works, &c.

(*h*) Students and such persons who already at the commencement of the war were preparing for a profession.

(*i*) Germans who before the war were resident abroad and who intend to return.

Other kindred questions, such as employment bureaus, &c., after the war, are receiving all due attention on the part of the German authorities.

In the meantime vast sums have been put aside by the majority of German industrial concerns of any importance for the benefit of those of their employees who are at the front and who will return more or less disabled. In this work masters and men have often worked in conjunction, through the medium of labour or work combines (*Arbeitsgemeinschaften*) which have been formed between masters and men in different branches, and most of which combines have the welfare of invalids for their object. At the end of the year 1916 there were 23 combines of this kind in Germany, 13 founded on a more central basis and 10 of a local nature. It has been suggested that these composite bodies should extend the area of their work to all departments where the interests of employers and employees run parallel, such as the transition from war to peace, the supply of raw materials, the supply of food, the improvement of the foreign exchange, commercial treaties, monopolies, the training of apprentices, &c., a movement which looks like a forerunner of an altogether altered state of affairs in bureaucratic Germany.

TUNGSTEN FILAMENTS.

A few months ago we briefly referred to a method of preparing tungsten filaments consisting of very long filiform crystals, which are highly flexible and yet do not soften at the high temperature of 2,500 deg. C. The original illustrated communication having meanwhile become available, we may revert to the subject, and to the interesting feature that the tungsten is improved by being mixed with thoria, though the discussion of this feature by the Bunsen Gesellschaft left the real part played by the thoria unexplained.

When tungsten filaments have been squirted in the ordinary way, they are heated up to a white glow by gradually increasing electric currents; the wires then shrink, contracting to about three-quarters of their lengths, and assume metallic lustre, but they turn hard and brittle. Strangely enough, tungsten filaments become more flexible when the metal is mixed with about 2 per cent. of thoria or of some other refractory oxide. This peculiarity was observed years ago, and the addition of thoria is not the monopoly of any particular firm. The flexibility obtained was, however, restricted; a wire might be bent at some spots, but would break at others; apparently the wire still consisted of crystals or columns of relatively short length, joined together end to end, like the tantalum filaments of the early days, and the failures were not due to impurities or want of uniformity in the mixture. In investigating the peculiarity in the laboratories of the firm of Julius Pintsch, Messrs. O. Schaller and H. Orbig etched the filaments with nitric and hydrofluoric acids, and observed that crystals, whose faces reflected the light in different directions, were embedded in a micro-crystalline mass; the crystals were soft and flexible at all temperatures, and they broke at joints with small contact area, but not so readily when grown into one another. Without the addition of thoria the investigators could not obtain flexibility. When the wires were etched the circular cross-section changed into a polygon, roughly a square, but really an octagon consisting of two four-sided prisms; the structure is, therefore, di-tetragonal, and it is noteworthy that both tungsten and thoria crystallise in the tetragonal system. Some kind of solid solution seemed to be formed, and the manufacturer had to try to make the crystals in the wire as long as possible.

For this purpose simultaneous heating of the whole wire by the current was evidently not suitable; crystal formation would then start simultaneously at many points, and the growth of a single crystal would soon be stopped by that of other crystals on either side. If the wire were only heated in the one direction, that is, if the wire were introduced into a hot zone at a rate not exceeding the rate of crystallisation, the crystallisation might proceed indefinitely in one direction. The process is being carried out by drawing the wire slowly through a furnace consisting of a spiral of a few turns of tungsten wire heated in a hydrogen atmosphere by the electric current to a temperature of about 2,500 deg. C.; the heating is therefore abrupt, but uniform all round. The wire is directly wound on a bobbin and apparently not further treated. Its tensile strength was described by W. Böttger (*Zeitschrift Elektrochemie*, April 1, 1917, pages 121 to 126) as being intermediate between that of steel and of drawn tungsten wire. This drawn tungsten, it was shown, bent under its own weight when heated to 2,500 deg., whilst the "crystal wire" remained firm, and the former lost much of its flexibility and strength and of its conductivity when kept at high temperatures for a few seconds, whilst the crystal wire stood heating for 1,000 hours without change. The General Electric Company, it was stated, made the drawn wire fibrous by mechanical treatment; when such wire was cut with the scissors it split into fibres, and the fibrous structure turned coarsely crystalline on continued heating, whilst the crystal wire did not develop any texture on being bent, cut or heated.

As regards the theory, it is believed that oxides (of copper, vanadium, platinum, iron, manganese, &c.) are somewhat soluble in their own metals; some of the rare metals like thorium have not yet been prepared in the pure state, and may contain several per cent. of their oxides; the melting-points of these metals are probably lowered by the presence of oxide. But this case, dissolution in a metal of a foreign oxide, looks different. On the other hand, it does not appear likely that the thoria acts as solvent for the tungsten; for higher percentages of thoria (more than 2) are injurious. Professor L. Wöhler mentioned a curious observation of his. He heated hydrogen and porcelain in the presence of platinum (or tungsten) and found that some silicon diffused into the platinum (or tungsten), though silica is not reduced under those conditions. One might think, then, that thorium dissolved in the tungsten as metal, not as oxide; but the white thoria remains behind when the tungsten is dissolved during etching. Technology may profit if scientists study the problem further.

THE CARBONISATION OF COAL.

Our knowledge of the nature of coal is very crude. In his "Carbonisation of Coal" of 1913 the late Professor V. Lewes wrote: "We make elaborate tables of the composition of gases and tars at various distillation temperatures, but the only information that the tables give us is what is left undecomposed under unknown and varying

conditions, the only certain factor being that the heat was nowhere above that which we are pleased to call the temperature of distillation." Even this latter statement may be questioned, and in carbonisation in bulk it is certainly doubtful whether the final products isolated are really primary products, liberated as such from the coal, and not secondary products due to reactions between the products in contact with the hot coal and hot walls. On the other hand it is not certain either that the various solvents which have been used of late to extract coal constituents really yield original constituents. But we have to distil coal, and therefore have to study the conditions under which the distillation is most profitable. For this purpose we require a knowledge of the real primary products, which should be withdrawn from the retort as rapidly as possible before they are changed by further interactions. Various experimenters have used vacuum apparatus with this object, and some neat apparatus of this type are described by Messrs. Guy B. Taylor and Horace C. Porter in Technical Paper 140 of the United States Bureau of Mines; this paper, we should mention, is a sequel to Bulletin 1, "The Volatile Matter of Coal," 1910. We will also notice some other researches on this occasion.

The first apparatus which Taylor and Porter tried—all the experiments were on a small scale with four kinds of coal—consisted of a vertical, tubular glass bulb, 22 mm. (nearly 1 in.) internal diameter, about twelve times as high. The lower end of the bulb dipped into the heating bath of fused salts; above that a side tube branched off to the pump; in the upper portion of the bulb was the device for dropping small charges of coal into the lower part. This device was a kind of sliding hopper, built up of two glass tubes and a cylindrical roll of sheet iron; by the aid of a solenoid surrounding the upper part of the bulb the device could be raised, and the coal dropped in small portions. The arrangement looks very clever, but the intermittent feed was given up because, with an experiment lasting 1½ hours, *e.g.*, the first charge was heated nearly that time longer than the last charge. The arrangement illustrated in Fig. 1 was hence adopted for some experiments. The charge was introduced into the bulb *a*, which was bent horizontally above the asbestos plug indicated; further beyond was a plug of glass wool, and at *b* the glass tube, which was open at the end, entered a cylindrical chamber which was joined to the pump and in which boats charged with phosphorus pentoxide and other absorbing agents were placed. In other apparatus the tube *b* was bent downward in order to collect the condensing vapours (tar, &c.). For vacuum distillation at 1,050 deg. C. the apparatus illustrated in Fig. 2 served. The glass bulb *a* was inverted and dipped with its stoppered end into a mercury cup. A glass tube *b* passed through the stopper up into the bulb and supported a rod on which the cylindrical cup *c* rested; against the outside of the cup bore the thermocouple wires, which were introduced through the tube; the electric furnace *f* was placed over the upper portion of the bulb, which the T of the tube *b* connected to the pump. The material of the cup, platinum or quartz, did not affect the results, it was ascertained. In studying the rate of vapour evolution at different temperatures a quartz bulb, lying horizontally in the furnace, was loosely connected by a short piece of rubber tubing to a small tube containing the charge; on turning the whole apparatus vertically the charge fell into the bulb, and the bulb itself could be plunged into cold water at the end of an experiment. Sometimes the distillation of the coal was carried on while a current of the gas generated passed through the bulb. The experimental arrangements and conditions were thus varied in many ways.

It resulted that more than two-thirds of the organic substance is decomposed at temperatures below 500 deg. C., the younger coals from the west breaking down more easily than older (Appalachian) coals. The constituents breaking down first are oxygen compounds of the cellulose type, and the chief products are then water, CO_2 and CO. Coal probably breaks down more or less at all temperatures, but hardly to any noteworthy extent below 250 deg. for bituminous Pittsburgh coal, but at lower temperatures for Western coal. Below 400 deg. lower paraffins, C_nH_{2n+2}, predominate in the volatile products; at temperatures above 750 deg. thermal decomposition of the volatile products into hydrogen and methane becomes pronounced. The tar yields are best at rapid low-temperature distillation; Pittsburgh coal gave 13 per cent. of its weight as tar below 500 deg.; water of decomposition is produced especially between 250 deg. and 500 deg., and this water reacts with the products; coal containing more oxygen compounds yields more water, less tar, and more CO_2 and CO than others, and for that reason coals of approximately equal volatile

Fig. 1. APPARATUS FOR DISTILLING COAL UNDER REDUCED PRESSURE.

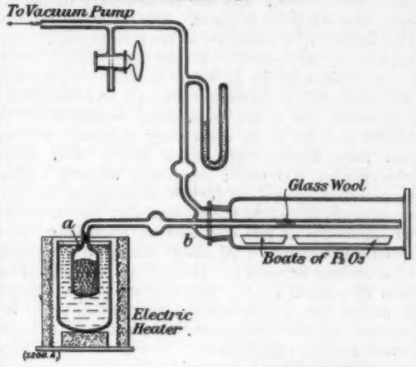
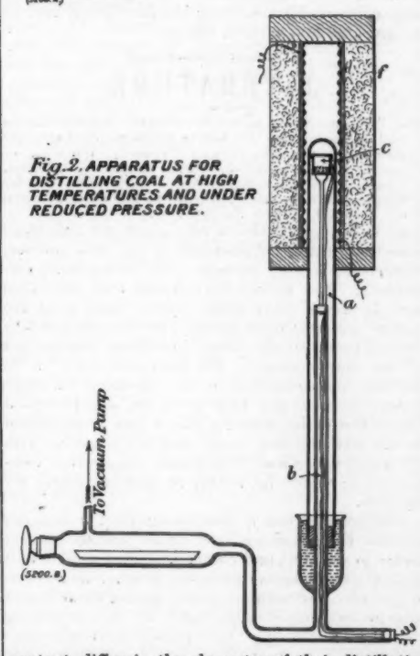


Fig. 2. APPARATUS FOR DISTILLING COAL AT HIGH TEMPERATURES AND UNDER REDUCED PRESSURE.



content differ in the character of their distillation products. By 900 deg. the Pittsburgh coal is practically free from volatile matter; a thin layer of that coal did not evolve any more gas after being heated to 900 deg. for 5 seconds, at any rate.

These results are more or less in agreement with other researches. R. V. Wheeler, D. T. Jones, and their colleagues, to whose work we have repeatedly referred, consider that there is a decomposition point of coal, marked by an increase in hydrogen evolution, between 700 deg. and 800 deg., and that coal probably consists of two main types of compounds, the one unstable, yielding mostly paraffins, the other more stable, yielding chiefly hydrogen. By the use of pyridine and chloroform as solvents they further separated the coal into resinous constituents and into humus-giving degradation products of cellulose, the latter yielding the hydrogen. This conclusion is not supported by Taylor and Porter, nor by the very interesting researches which H. J. Hollings and J. W. Cobb, of Leeds, presented to the Chemical Society in 1915. By heating the respective coal and a coke (which could be regarded as chemically and thermally inert) in boats side by side under the same conditions and noting, by means of a differential arrangement of thermocouples, the rise and fall in the coal under carbonisation in a current of nitrogen, they obtained "heating curves" of different coals, anthracite, lignite and, further, of cellulose, dehydrated cellulose, and of pyridine extract of coal and of its residue. They observed an evolution of heat from cellulose at 345 deg. C., accompanied probably by a loss of hydroxyl groups; this evolution was less marked in dehydrated cellulose, and hardly or not at all noticeable in lignite and in coal. The differences of various kinds of coal as to oils, unsaturated hydrocarbons, higher paraffins and oxygenated compounds became most pronounced between 400 deg. and 600 deg.; between 600 deg. and 800 deg. heat was again evolved by all coals and methane was liberated; above 800 deg. the coals proved thermally neutral or slightly endothermic (heat absorbing). The thermal phenomena were, at low temperatures, only noticeable in coals high in oxygen; at high temperatures they were most marked with coal low in oxygen (anthracite). The pyridine extract and its residue did not differ thermally in any characteristic manner.

Taking into consideration also the results of researches by Rau and Lambris, Parr and Olin, Pictet and Bouvier, and by Vignon, to which the names of Bantlin, Büttner and Wislicenus might be added, Taylor and Porter conclude that a high-grade bituminous coal (gas-making type) decomposes by heat primarily into water, CO_2, CO and paraffin hydrocarbons, and into a completely altered non-volatile residue; the quantity of water, CO_2 and CO is small in gas coal. The superheating of these products gives rise to complex secondary reactions in industrial carbonisation at high temperature. At low temperature (427 deg. to 482 deg. C.) Pittsburgh coal yields 0.6 cub. ft. or 0.7 cub. ft. of rich gas per pound of coal, and much tar and oil (10 per cent. to 12 per cent.), consisting chiefly of paraffin hydrocarbons, but practically no free carbon nor benzene and naphthalene compounds. The gas contains 6 per cent. or 7 per cent. of unsaturated hydrocarbons and 20 per cent. to 25 per cent. of methane and its higher homologues, and is of high calorific and illuminating value. The tar may be redistilled or cracked to produce light gasoline oils, quite twice as much as high-temperature carbonisation would yield. Technically, hence, a thin gas (blue water-gas) might profitably be passed through low-temperature retorts to sweep out the light oils, and inferior coal might be better utilised in this way.

As regards the constitution of coal, Taylor and Porter assume that all coals consist of degradation products of cellulose and of resinous substances, in different proportions, all altered by ageing. The less-altered cellulosic constituents are the most easily decomposed by moderate heat, and give water, CO, CO_2 (little of these if the coal be mature) and hydrocarbons. The resinous derivatives yield principally paraffins and, further, hydrogen. Mature bituminous coals (with good coking properties) contain a large proportion of resinous constituents, together with highly-altered cellulosic compounds. Younger bituminous coals consist chiefly of less-altered cellulosic derivatives; they undergo considerable decomposition before they fuse, and do not coke partly for that reason.

NOTES.

ALLOYS OF NICKEL-COPPER WITH CHROMIUM AND MANGANESE.

IN attempting to prepare superior resistance materials suitable for the dissipation of energy, as well as for standards and for the adjustment of instruments, Messrs. F. M. Sebast and G. L. Gray, of the Rensselaer Polytechnic, Troy, New York, started from nickel-copper, which they fused in Arsem vacuum furnaces together with either chromium or manganese. Four sets of chromium alloys were made, containing 5, 10, 15 or 20, and also 25, parts by weight of chromium per 100 parts of copper and nickel counted together. It was noticed (Transactions, American Electrochemical Society,

vol. 29, pages 569 to 578) that the addition of pure chromium to pure copper increased the resistance of the copper only to a very slight extent, because the chromium is hardly soluble in copper, whilst the resistance of nickel was greatly increased by the addition of chromium, with which it forms a solid solution. When chromium was added to the Cu-Ni alloys, which were prepared in all proportions, the resistance first rose and then diminished; there was a maximum for each chromium concentration, depending upon the percentage of copper in the original alloy. Whenever the resistance of an alloy was increased by the addition of chromium, the temperature coefficient was reduced and *vice versa*. An alloy of very high resistance, 112 microhms per centimetre, and of a very small temperature coefficient, 0.000078 per deg. Centigrade at 20 deg. C., seemed to be of considerable commercial promise; this alloy consisted of 20 per cent. of chromium in an alloy of Cu-Ni containing 15 per cent. of copper. Of the manganese alloys, three sets were prepared in the same way by adding 5 per cent., 8 per cent. and 15 per cent. of manganese to nickel-copper alloys of different proportions. The addition of manganese always increased the resistance of the alloy, and this increase in the resistivity was again accompanied by a diminution of the temperature coefficient and *vice versa*. From the study of the curves the experimenters conclude that an alloy approximately of 15 per cent. of manganese added to a Ni-Cu alloy containing 55 per cent. of copper and 45 per cent. of nickel had the high resistance of 70 microhms per centimetre and practically no temperature coefficient at 20 deg. C. This new alloy would hence be a resistance material for precision instruments even better than that just mentioned, and superior to those so far in use.

Iron-Aluminium Alloys.

Although Sir Robert Hadfield and Sir W. Barrett observed in 1893 that some aluminium-iron alloys had better magnetic properties than the purest iron obtainable, these alloys have not been much studied. The difficulty of their preparation, particularly of keeping the carbon out, may be partly responsible. In their recent research T. D. Yensen and W. A. Gatward (Bulletin 95, of 50 pages, Engineering Experiment Station, University of Illinois) experienced sufficient difficulty when using an Arsem vacuum electric furnace at a pressure of less than 1 mm. of mercury. Their refined electrolytic iron contained 0.01 per cent. each of carbon and silicon, their aluminium 99.63 per cent. of Al (the rest iron and silicon). When they tried to fuse the two metals together, aluminium volatilised and the little Al_2O_3 formed would not rise, but coated the iron. They then fused the iron and dropped the Al rods—previously suspended in the furnace by a thin wire which was fused by the current at the right moment—into the molten iron; even then the hot aluminium, though shielded against radiated heat as much as possible before fusing, decomposed the CO in the furnace, becoming covered with carbon and alumina, and introduced more carbon into the alloy. In this way some of the alloys became contaminated with up to 0.65 per cent. of carbon. There was further contamination when liquid aluminium drops came in contact with the graphite funnel, which was later replaced by a funnel of alundum or magnesia; the crucible was of magnesia. The resulting alloys, considered uncontaminated when containing 0.02 per cent. of C as a maximum, were tested as forged or after annealings at 900 deg., 1,000 deg. and 1,100 deg. C. and cooling at the rate of 30 deg. per hour; during annealing the gas pressure in the furnace did not exceed 0.2 mm. of mercury. Aluminium was found to be a more powerful deoxidiser of iron than silicon, forming solid solutions with the iron only after all oxides present were reduced. The tensile strength of the vacuum alloys increased proportionally to the Al percentage (up to 6 per cent. at least), the ultimate strength of the annealed and unannealed alloy with 6 per cent. Al being 85,000 lb. and 70,000 lb. per sq. in. (against 48,500 lb. and 35,000 lb. for pure iron); the toughness of the iron was little affected by the Al. Magnetic tests were conducted by the compensated double-bar method of C. W. Burrows (of the Bureau of Standards), although that method was known to require correction in very strong fields, because the authors had used the same method previously in studying silicon alloys. Like Si, Al had a beneficial magnetic effect when added in small quantities. An alloy with 0.4 per cent. Al, annealed at 1,100 deg. C., gave the maximum permeability of more than 35,000; the hysteresis loss for B max. = 10,000 or 15,000 was 450, or 1,000 ergs per cubic centimetre per cycle. With higher Al percentages the great magnetic improvement was not maintained, but the alloys were less brittle than the corresponding silicon-irons. The 3.5 per cent. Al alloy gave a maximum permeability of 20,000, with hysteresis losses of 1,000 and 2,200 ergs; this loss was only half that of commercial 3.5 per cent. silicon iron, and the permeability of the Al alloy was six times as great. The magnetic properties proved very sensitive to heat treatment. The maximum permeability of the unannealed alloys varied from 3,500 for pure iron to 600 for 6 per cent. Al; annealing at 1,100 deg. affected pure iron little, but raised the 6 per cent. alloy permeability to 17,000 and the 6 per cent. alloy to nearly 40,000, and these figures were much better than those obtained at 900 deg.; annealing at still higher temperature offered no further advantages, and for weak fields, H = 200, the permeability was the same for annealing at 900 deg. and at 1,100 deg. The specific resistance of Al alloys increased by about 12 microhms for each per cent. Al up to 3 per cent., then at a smaller rate; this increase was so regular in carbon-free alloys that the composition could be checked by the resistance-curve, which was little influenced by temperature. Low-grade Al alloys appear promising, therefore; but they would have to be prepared in a vacuum furnace.

LITERATURE.

The Premium Bonus System: A Scheme for Stimulating and Increasing the Productive Capacity of Industrial Resources. By W. Rowan Thomson, Wh.Sch., of David Rowan and Co., Marine Engineers, Glasgow, President of the North-West Engineering Trades Employers' Association. Glasgow: McCorquodale and Co., Limited. [Price 5*s.* post free.]

The title-page of this work, which we reproduce somewhat fully, supplies the place of a preface, announcing a high purpose and distinguished credentials. The Rowan system has been described and discussed many times before; and what the author has now tried to do is to convert it into a contribution to the future industrial foundations of the commonwealth. His joint authorship of the method, his partnership in the establishment where it was devised and first used, the uninterrupted experience of its working that he has accumulated in the last nineteen years, and his relations with the hard-headed and enterprising engineering community in which he works, fit him eminently for his task.

The book is less a description than a manual, and has the advantage over many manuals that it seems to seek out and corner whatever doubts and difficulties may beset its subject, whether in theory or in practice, and with an almost quaint anxiety and care to tie them up in the bonds of first principles, common knowledge, and numerical evaluation. Appealing as he does to competent and responsible men in charge of substantial works, the author would, indeed, seem to be too minutely careful to leave no difficulty unexamined and unsolved, if account were not taken of the immense importance of attaining the utmost possible certainty in any change that may now be made in the fundamental methods of industry. The book is short, and has every device (except an index) by which paper, print, and good arrangement can lighten what in any form would have been the light labour of reading it. There is accordingly no point in trying to follow the author into the many interesting propositions by which he seeks to define and assure his argument. A sketch of some parts of its general structure will perhaps give a clearer view of what is to be got out of it.

What distinguishes the Rowan system in any form from the others with which it is compared (piecework and the Halsey system) is that its premium is a variable fraction of the time saved on the job, which fraction gets less as the time taken gets less and the time saved gets more; whereas in other systems the premium is a fixed fraction of the time saved, a fraction that in the limiting case of piecework amounts to unity, or the whole of the saving. The Rowan premium is thus made up of two variable factors, the time saved and a proper fraction which decreases as the time saved increases; so that in the limit, when the time saved is very great, the fraction is very small, and their product may be expected to have—and in fact has—a finite value. In the other two systems the only variable factor in the premium is the time saved; and when this saving grows very large, the premium grows very large with it, and in the limit must itself become infinitely large. In comparing systems the first thing necessary is to know precisely how they will work; and Mr. Thomson gives a series of tables and curves showing the effect of the several systems on the labour cost of the job (*i.e.*, the workman's earnings), the output, and the workman's earnings per hour. The net effect is to show that on the usual Rowan system, in which the premium is the ratio of time taken to time allowed, the pay for the job (*i.e.*, the labour cost) and the amount of premium on it reach a maximum when a saving of 50 per cent. is reached on the time allowed, while the hourly rate of pay increases, up to a limit of double pay, in direct proportion to the increase in the time saved. In piecework and the Halsey system, on the other hand, the total pay or labour-cost and the premium rise in direct proportion to the increase in time saved, and the hourly rate can thus rise without any limit. In an appendix the author discusses a more general formula, in which

the premium is not $\frac{\text{time taken}}{\text{time allowed}} \times$ time saved,

but $\frac{\text{K (time taken)}}{\text{K (time taken)} + \text{time saved}} \times$ time saved,

the former fraction being obviously the value of the latter when K, a constant, = 1. Each value of K fixes the maximum premium that can be attained, and the percentage of saving at which it will be reached. Thus by giving K a suitable value the system can make the maximum premium as much or as little as desired, or can fix it at any desired percentage of time saved, or provide any desired maximum increase of hourly wages; or, alternatively, can fix at any desired percentage of saving the point at which double wages will be earned. In all these variations the general formula retains the fundamental character of the particular case, that for finite values of K the hourly rate remains finite, and the premium reaches a maximum before the total time allowed for the job has been spent.

These points are brought out clearly in the tables and curves, and by many illustrations it is shown that the effect of the system as usually practised is to minimise the result of inaccuracy in rate-setting, and to reduce the temptation to cut rates to a point at which, in the author's view, it should be within the moral strength of an average employer. This merit of the system has long been recognised by some, at least, of the most prominent trade-union leaders; and though it involves the disadvantages that the attainable maximum pay is limited—in the usual system, to double time—and a man's premium falls off progressively after he has attained the maximum, Mr. Thomson observes justly that in most engineering work rates should be set close enough to exclude more than double pay from practical work. A series of tables show how relatively insensitive the system is to errors in rate-setting; but at the same time the author lays stress on the importance of getting rates as nearly accurate as possible, though he asserts that the only correct standard is to be obtained from the actual performance of the average man on time work "while giving a fair output," or, alternatively, "the time which has been taken day after day in the past." In many shops this basis would be profoundly misleading; and in his own firm's rules the standard is expressed as "the time which should be taken to the job, when working on time," a quantity not necessarily the same as the time that has been taken.

A chapter on practical application gives the actual regulations that have been maintained in the author's firm unchanged since their first

introduction at the beginning of 1898, including an admirable system of "weight for age," by which apprentices can be put on to standard rates and be handicapped well in the running with older men, and some details of forms and of the application of the premium to squad work.

Incidental tables are given to clear up arguments sometimes advanced against premium systems in general. As against the suggestion, for instance, that the strain on the men is excessive, a table shows the number of men who made over 40 per cent. premium in a given year (1909) was 54 per cent., their average age 43, and their average service 13 years, the system having been started 11 years before. The results of seven of the oldest men, varying in age from 44 to 70, with an average age of 54, and average service from 18 years to 38, showed an average premium of 49 per cent., and the oldest of them made the most—53 per cent.; that is to say, beginning to work on the system at the age of 59, this man was doing 11 years later over double the output at which he started, and the other men not much worse. Many instances are also given of the actual results on definite jobs, and some advice on the choice of a system; bringing out the view that the Rowan system, while adapted to all classes of work, finds an application that the author regards as practically indispensable to those trades in which accurate rate-setting is the most difficult, and intensive repetition work, with a minimum of time on work-setting and tool-setting, is the least frequent.

The importance of the Rowan system lies in the fact that it provides above all for the middle cases—for works that do not aspire to the most intense production, and men who are not dazzled by the possibility of fancifully high wages. Mr. Thomson's experience shows—and it has been confirmed abundantly in other works than his—that the virtues claimed for premium systems of enlisting the entire establishment co-operatively on doing the best for the job, of teaching the employer what he would not otherwise learn of the weak places in his works, of giving the workmen the honest pride in increased earnings that comes from the knowledge that they are earned by work and not merely extorted by negotiation, are to be found within the safe and theoretically modest limits that the system puts to itself. The brilliant extremes to be developed by more intensive systems may not be found in it. Taylor's noble assertion that his system worked with none but first-class men, and that he had never found a man who could not be made first-class at some job, does not stand to be tested on the Rowan system. It is impossible to suppose that one uniform system of payment could be adopted in all works. What is most to be hoped is that good examples will be found of all systems. It would be hard to exaggerate the value of intensive methods, such as Taylor's, not only for the direct gain in output, but for the standard which they have to set in conditions of work, shortness of hours, and even in circumstances of life out of working hours, if the best result is to be attained. Such standards in practical operation as part of the mechanism of a successful works are worth more than any amount of theoretical exposition. But when all is said and done, the needs of the middle-class man, the requirements of the temperate system, can be satisfied much more easily than the more ambitious ideals of Taylor, and require a far less extensive staff of high-class men for introducing and carrying on the necessary mechanism. For immediate purposes there is much to be said for Mr. Thomson's contention that his system is more suitable than others to a great majority of existing works; and that so excellent a presentation of it should have been given as is to be found in this volume is a matter on which industry at large is to be congratulated no less than the author.

Treatise on Hydraulics. By MANSFIELD MERRIMAN. Tenth edition, revised with the assistance of THADDEUS MERRIMAN, Member of American Society of Civil Engineers. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 18*s.* 6*d.* net.]

MR. MERRIMAN'S treatise on hydraulics is nearly as well known on this side of the Atlantic as in the United States, where some or other of the ten editions must have been the friend and companion of many an engineer who has climbed to eminence in the last thirty years. The kindly criticisms of teachers and professors will have assisted in moulding the form of this classic, while the progress of mechanical science must have decided the character and extent of the emendations. Alert response to varying conditions has been necessary to keep the work abreast with advancing science, and it would prove a very instructive task for a student of hydraulic science to compare the first with the last edition. It is doubtful to what extent the cardinal points on which progress in this branch has turned were recognised in those distant days, and whether the road actually travelled could have been foreseen from the time of the initial effort; for the equipment of hydro-electric plant, the gigantic plans on which irrigation works have been conceived, the ever-increasing schemes for the transmission of water for municipal purposes, have given rise to many new problems and have directed energy into unexpected paths. Approximate formulæ that served when construction was on modest lines have been tested with great severity, and though as a rule they have not been found wanting, yet much original work has been accomplished in the interval, the results of which have to be assimilated and the methods of derivation described, and perhaps justified. A later generation has to be guided by the accumulated experience of the preceding, and the author, to succeed, has to accommodate his work to the urgent needs and wider outlook of new aspirants. Mr. Merriman's experience has been equal to the task, and he will remain the mentor of the present, as he was the guide of the last, generation. Much remodelling has been necessary from time to time, the more so as the author has always endeavoured to fulfil the apparently incompatible tasks of catering for the advanced mathematical student and meeting the requirements of the practical engineer. In proportion as the educational needs are satisfied on the one hand, it would seem that the other must be sacrificed.

There is little need to dwell on the contents of a treatise so well known. The first four chapters, on "Fundamental Data," "Hydrostatics," "Theoretical Hydraulics," and "Instruments and Observations," have apparently been reproduced from former editions without change. The new matter introduced will be found mainly in the next six chapters, in which are discussed various kinds of flow, namely, through orifices, through weirs, through pipes and tubes, in conduits, and in the flow of rivers. Proportional weirs, Biel's formula—a recent rival of the well-known Kutter equation, whose factor *n* has been a weariness to so many—and back water due to bridge piers are made the subjects of new and extended comment. The author's plan of maintaining consecutively-numbered articles, each dealing with a special subject or division of a chapter, has required these interpolated sections to be distinguished by a fraction, a rather cumbersome method of numeration and one that points to entire remodelling in the near future.

The remaining six chapters appeal more particularly to the trained engineer. They are devoted to the application of theory to such intensely practical subjects as "Water Supply and Water Power," "Dynamic Pressure of Water," "Water Wheels and Turbines," "Naval Hydromechanics" and "Pumps and Pumping." The additional subjects introduced are "Water-hammer" and the method of surge tank control. This latter subject is dropped rather suddenly and the amount of information supplied is not great. The space devoted to turbines and hydraulic machines will be thought by many to be inadequate, but a still more liberal treatment would have left the material unexhausted, and recourse to technical monographs inevitable. Several sections have been rewritten and the matter is planned to afford a general outlook over a large subject. In these chapters, and again in that on "Pumps," the author must have wished to include references to many forms that he has been obliged to omit from considerations of space. The new matter inserted is so far interesting that it indicates the direction that an experienced author and teacher thought would prove most instructive for illustration.

The diagrams remain apparently unaltered, and the method of making the number of any illustration identical with that of the article to which it refers is preserved. Where more than one diagram is necessary in the same article, distinction is made by the addition of letters. Formulæ have also the same number as the article, with numbers attached when several equations are derived in the same article. The plan, though unconventional, is not without its advantages, and has been continued from former editions. Many useful tables are given in an appendix, but do engineers ever use nine-figure logarithms?

BOOKS RECEIVED.

United States Geological Survey. Bulletins. No. 627. *The Lignite Field of North-Western South Dakota* By DEAN E. WINCHESTER, C. J. HARES, E. RUSSELL LLOYD and E. M. PARKS. No. 630. *The Chisana-White River District, Alaska.* By STEPHEN R. CAPPS. No. 635. *Spirit Levelling in Georgia,* 1896 *to* 1914, *Inclusive.* No. 636. *Spirit Levelling in Arkansas,* 1896 *to* 1915, *Inclusive.* No. 638. *Spirit Levelling in New Mexico,* 1902 *to* 1915, *Inclusive.* By R. B. MARSHALL. No. 645. *Bibliography of North American Geology for* 1915, *with Subject Index.* By JOHN M. NICKLES. No. 649. *Antimony Deposits of Alaska.* By ALFRED H. BROOKS. Washington: Government Printing Office.

United States Geological Survey. Mineral Resources of the United States. No. I: 3. *Secondary Metals in* 1915. By J. P. DUNLOP. No. I: 4. *Manganese and Manganiferous Ores in* 1915. By D. F. HEWETT. No. I: 5. *Silver, Copper, Lead and Zinc in the Central States in* 1915. *Mines Report.* By J. P. DUNLOP and B. S. BUTLER. No. II: 13. *Asphalt, Related Bitumens and Bituminous Rock in* 1915. By JOHN D. NORTHROP. No. II: 14. *Gypsum in* 1915. By RALPH W. STONE. No. II: 16. *Cement in* 1915. By ERNEST F. BURCHARD. No. II: 17. *Sand and Gravel in* 1915. By R. W. STONE. No. II: 19. *Lime in* 1915. By G. F. LOUGHLIN. No. II: 20. *Salt, Bromine and Calcium Chloride in* 1915. By W. C. PHALEN. Washington; Government Printing Office.

The Trade of To-morrow. By ERNEST J. P. BENN. London: Jarrolds, Limited. [Price 2*s.* 6*d.* net.]

Logarithms for Beginners. By CHARLES N. PICKWORTH. Sixth Edition. London; Whittaker and Co. Manchester: Emmott and Co., Limited. [Price 1*s.* 2*d.* post free.]

The Indicator Handbook. By CHARLES N. PICKWORTH. Part II. *The Indicator Diagram: Its Analysis and Calculation.* Sixth edition. Manchester: Emmott and Co., Limited; London: Whittaker and Co. [Price 3*s.* net.]

Bognor and its Neighbourhood. By ARTHUR HENRY ANDERSON. London: The Homeland Association, Limited. [Price 7*d.* net.]

Practical Costing. By A. H. GLEDHILL, A.M.I.Mech.E. London: The Gledhill-Brook Time Recorders, Limited, 26, Victoria-street, S.W. [Price 3*s.* post free.]

Naval Architecture. Part I. By J. E. STEELE, B.Sc., M.I.N.A. Cambridge: The University Press.

Cycling Manual: The Choice, Care and Repair of the Bicycle. London: The Temple Press, Limited. [Price 7*d.* net.]

The Principles of Industrial Administration. By GEORGE EDSON TOOGOOD. With Introduction by W. L. HICHENS. London: A. Brown and Sons, Limited. [Price 1*s.* net.]

Cours de Géométrie pure et Appliquée. Par MAURICE D'OCAGNE. Tome I. *Transformations Géométriques—Perspective—Géométrie Infinitesmale—Géométrie Réglée—Géométrie Cinématique.* Paris: Gauthier-Villars et Cie.

The Book of the Ford. By R. I. NICHOLSON. Second edition. London: Temple Press, Limited. [Price 1*s.* 9*d.* net.]

The Predetermination of True Costs and Relatively True Selling Prices. By FREDERICK A. PARKHURST, M.E. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 5*s.* 6*d.* net.]

Technica Moderna degli Acciai. By CARLO GOFFI. Milan: Ulrico Hoepli. [Price 4.50 lire.]

Lavorazione e Tempera degli Acciai. By ARTURO MASSENZ. Third edition, revised. Milan: Ulrico Hoepli. [Price 2.50 lire.]

The Public School System in Relation to the Coming Conflict for National Supremacy. By V. SEYMOUR BRYANT, M.A., with a Preface by LORD RAYLEIGH. London: Longmans, Green and Co. [Price 1*s.* 6*d.* net.]

Steam Turbines; a Practical and Theoretical Treatise for Engineers and Students, including a Discussion of the Gas Turbine. By JAMES AMBROSE MAYER, S.B., A.M. Third edition, revised and enlarged. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 16*s.* 6*d.* net.]

DEALINGS IN WROUGHT IRON AND STEEL SCRAP.—The Minister of Munitions has modified the general permit as regards dealing in wrought iron scrap, and has issued a notice of amendment to the general permit in regard to dealings in certain steel scrap. Both notices are dated the 27th inst., and are accompanied by lists of maximum prices. All communications concerning both are to be addressed to the Director of Steel Production, Room 381, Ministry of Munitions of War, Whitehall-place, London, S.W. 1.

INDUSTRIAL NOTES.

The Minister of Munitions, Mr. Churchill, accompanied by Mr. Kellaway, met the executive of the Cumberland Iron Ore Miners' Association last Friday to discuss the demands made by the miners which had led to the stoppage of work in the West Cumberland iron-ore field. After full discussion of all the points at issue a complete settlement was arrived at which provided for the promotion of certain classes of labourers and immediate increases to others, together with a promise of further increases based on an additional output. On the men's side the agreement comprised the promise to recommend an immediate resumption of work, to agree that this should be a settlement for the period of the war, and to agree to the introduction of outside labour to help to increase the output of munitions.

In a statement issued to the Press last Friday, from the offices of the War Cabinet, Mr. George N. Barnes refers to the reports of the Commissioners of Inquiry into Industrial Unrest (which we analysed briefly on pages 116 and 144 *ante*), and says that whilst it is too early to expect that full effect should have been given to all the recommendations, substantial progress has been made. From Mr. Barnes' statement we note, briefly, the following points:—The Food Controller has now formulated a definite scheme for the reduction of prices, the stoppage of profiteering and the regulation of the distribution of essential foods; this scheme is on the point of being put into operation. The Munitions of War Amendment Bill, which has now received Royal Assent, safeguards the interests of labour as regards changes of piece rates; it gives power to the Minister of Munitions to abolish leaving certificates—a power which he hopes to exercise within the next few weeks, *i.e.*, as soon as certain outstanding questions relative to the safeguards required have been settled. The chief of these safeguards is that adjustment of time rates should be made to prevent the migration of skilled labour to less skilled, but more highly-paid, employment on piece rates. A special committee, comprising representatives both of trade unions and employers, has been appointed to consider the question (to which the Commission drew attention) of the discrepancy between the earnings of skilled time-workers and unskilled piece-workers. At the same time the Act gives power to make awards binding on all in the trade concerned. A committee of trade unionists is in course of appointment, and will advise the Minister of Munitions on industrial questions. In regard to the operation of the Military Service Acts, the position has been changed by the transference of recruiting to a Civilian Department. In the matter of housing a far-reaching scheme of housing after the war is being undertaken by the Local Government Board through the local authorities. It is hoped that immediate action may be possible in certain areas indicated by the Commissioners where the housing problem is acute. The statement further covers liquor restrictions; agricultural wages; workmen's compensation and other points. In regard to workmen's compensation, Mr. Barnes says that the Workmen's Compensation (War Addition) Bill was introduced in consequence of representations made by certain of the Commissioners that the maximum of 1*l.* payable under the Acts previously in force was now inadequate. It was pointed out, however, that a mere increase of the maximum would not assist the class most in need of an increase, viz., those whose earnings were below 2*l.* a week, and who, therefore, were not eligible to receive the maximum of 1*l.* compensation. Accordingly, provision was made for an addition to each weekly payment of compensation of a sum equal to one-fourth of the amount hitherto payable. The Bill has now received Royal Assent. The statement concludes with the following remark: "The far-reaching recommendations on the relations of employers and employed and the setting up of trade constitutions are being actively dealt with. These, however, are matters which cannot, and should not, be dealt with hurriedly. From the above brief outline it will be seen that practical effect has been given to such recommendations as were capable of being put into operation without delay; and I venture to think that the record is one of which everyone who has been associated with the Commission of Inquiry into Industrial Unrest may well feel proud."

Special attention was drawn in the report of the Commission of Inquiry into Industrial Unrest to the disturbing effect of the existing discrepancy between the wages of skilled men on day work and those of semi-skilled men on piece-work in munitions factories. The Minister of Munitions, after full discussion with both sides, decided to introduce into the Munitions of War (Amendment) Act, 1917, a provision whereby he may give directions by Order regarding the remuneration of munitions work which is being paid at time rates. With a view to arriving at an immediate decision as to the Order to be made regarding the skilled day workers the Minister has appointed a committee of representatives of the Ministry of Munitions, the Admiralty, the Ministry of Labour, and of various employers' federations and trade unions, with the following terms of reference: "To inquire into and to report upon the rates of skilled men on munitions work employed on day rates, with special reference to the discrepancy between such rates and the earnings of less skilled men engaged under systems of payment by results, and the possible effect of this discrepancy in view of the decision to abolish the provisions of the Munitions Acts dealing with leaving certificates; with due regard to the public interest, both in the matter of expense and of the increased output of munitions of war." The secretary is Mr. John Murray, Ministry of Munitions, to whom communications on the subject should be addressed at 6, Whitehall Gardens.

The Secretary of the Admiralty announces that, with the consent of the Minister of Munitions, Sir R. Sothern Holland and Sir H. Ross Skinner have been transferred from the Ministry of Munitions to the Admiralty for special work in connection with the Board of Invention and Research.

Conferences in which took part the British, French and other missions which went to the United States in order to give America the benefit of their experience in handling war problems, have brought out the fact, says *The Iron Age*, that during the war there has been a net increase of more than 1,000,000 in membership in British trade unions, despite the enlistments, *i.e.*, that the number who joined the unions exceeded the number who left the unions to go to the front by more than 1,000,000. We were accustomed before the war broke out, adds the American journal, to regard the United Kingdom as suffering from trade unionism and unable to progress industrially as greatly as Germany largely on that account. We are now given reason to conclude that the war is increasing the United Kingdom's handicap in this respect.

"What of the United States?" asks the American journal, which further says: "Our employers have not been given advice growing out of the experience of the United Kingdom. Our trade unions have been given advice on their side of the matter. It is true, of course, that early in the war the effort to push industry was overdone, and men were worked too hard, it being found later that a reduction in working time resulted in increased outputs. There is no possibility of our making such a mistake, for the simple reason that labour refuses. American employers would be well content to receive a normal day's work for the greatly increased day's pay they are giving.

"There is no hope of relief in the labour situation through the operation of natural influences. The only thing that is being done is to enact, long after the proper time, the Food Control Bill, for the purpose of reducing the cost of living. That is, on general principles, an excellent thing to do, but it will not increase the performance of labour. One of the difficulties in the situation has been that many men, in order to provide themselves with what they desired, did not need to work full time. If they can purchase what they need for less money they will presumably be disposed to work still less. Thus the trends in the labour situation at present appear to be three: men being called to the Colours; more labour unions; less work per week. It is high time, in the circumstances, that employers take united cognisance of the situation and seek such palliation of the conditions as may be secured."

The following is an abstract (in translation) of an article in the French journal *L'Industrie Electrique*:—

"Now that the justice of our cause has given us the United States as an ally, it is interesting to note the opinion of the well-known French author and expert, M. Victor Cambon, in regard to the American nation. 'The men who have made the United States,' says M. Cambon, 'that is to say, who have created the most admirable political constitution, the most gigantic industrial enterprises and the most productive organisations in the whole world, are the only men capable of helping us in France to correct our mistakes, to execute the work we have left in abeyance and to make good our accumulated ruin. Proper pride on their part, their sympathy and their interest will be united to stimulate them in the carrying out of the task. Some French people are disconcerted at this prospect and are afraid that the Americans will remove from France her riches and the profits of her work. These timorous persons are those,' adds M. Cambon, 'who believe that after the present upheaval they will be able quietly to take up the thread of their small antiquated businesses and of their little individualistic existence. There have always been people who learn nothing and forget nothing. The time of small things is passed,' concludes the French expert, 'it will never more return, and in the future business will be done in the American way or no business will be done at all, and for this the aid of example of Americans is necessary.'"

The Executive Committee of the Miners' Federation of Great Britain met the Controller of Coal Mines last Tuesday, and put before him a request for an increase of 25 per cent. on present earnings.

Mr. Smillie, the president, and Mr. Herbert Smith, the vice-president, of the federation, stated the grounds on which the request was based.

The Controller undertook to lay the matter before the Government and to communicate the result to the secretary of the federation at the earliest possible moment.

It was reported that the miners in one of the important Midland areas were at present working out their notices, and threatened to come out on strike unless an immediate advance in wages was given. The Controller of Coal Mines and the executive of the Miners' Federation expressed the hope that no action of this kind would be taken until the Government had had time to consider the application put forward.

With regard to the Mersey boiler-makers' dispute, to which we referred last week, *The Liverpool Courier* states that the Mersey Boiler-makers, Iron and Steel Shipbuilders' Society decided last Sunday, at a mass meeting, to resume work on Monday morning, on certain stated conditions. Mr. J. W. Bell, chairman for the district, presided, and it is estimated that there were about 4,000 men present. Just over 2,000, however, voted, and of this number 856 were against the motion that they should return to work.

The resolution was worded: "That we return to work in the morning on condition that a court of arbitration is set up immediately. The employers have agreed to have the case heard locally, that is that a neutral chairman be appointed, with an assessor from our side."

On this being put to the meeting, 1,309 voted for and 856 against, a majority of 453.

The case will be dealt with under the Munitions of War Act.

At the council meeting of the Tootal Broadhurst and Lee Company, cotton goods manufacturers, held last Tuesday in Manchester, Mr. E. Tootal Broadhurst mentioned the decision of the directors to set aside a sum of 10,000*l.* a year for five years for research work and education. The lessons taught by the war, he added, were partly responsible for the company's decision in this matter. They were of opinion that without improved education and a closer link between science and industry their future trade could not be expanded as it should. The sum referred to was to be devoted to the interests of the company, and although some of the knowledge gained might be of general use to the industry, the research work would be primarily for the company's own benefit. They were, however, ready to join in any public scheme for research, and they had already signified their intention of becoming members of the British Cotton Research Association. One of the lessons taught by the war was that the trades of this country had not been sufficiently allied with science. Many people, no doubt, had learned this lesson, and one result would be a demand for chemists and physicists, probably greater than could be supplied from existing sources. The directors therefore felt that they must prepare to produce scientific men from the *personnel* they had. The scheme, however, took a wider view than the production of scientists and technologists, and aimed at improving the general efficiency of all their employees.

The Goldsmid Engineering Entrance Scholarship, University College, London.—The examination for the Goldsmid Engineering Entrance Scholarship at University College, London, value 30*l.* a year for three years, will take place in September. Candidates should apply to the Secretary of University College, London, for full particulars as soon as possible, and not later than September 11.

Joint Technical Catalogues: Aeronautics.—The Libraries Committee of the Glasgow Corporation have sent us a copy of the first of a series of special catalogues of books which, by arrangement with other library committees in the city, are being published as guides to the collective resources of local libraries. It is felt that all manufacturers, workers and students will be interested in these lists of books, which bear directly upon matters of great industrial or commercial importance locally, and the committee trust that the lists will have the effect of widely disseminating a knowledge of the special literature available to readers. The first issue deals with aeronautics. There can be no doubt that a closer acquaintance with the literature of the subjects touched upon will assist in a more intelligent grasp of the principles and details of manufacture, resulting in better methods and a consequent improvement in production.

INTERNAL COMBUSTION FARM DRAINAGE MACHINES.

CONSTRUCTED BY THE PAWLING AND HARNISCHFEGER COMPANY, MILWAUKEE.

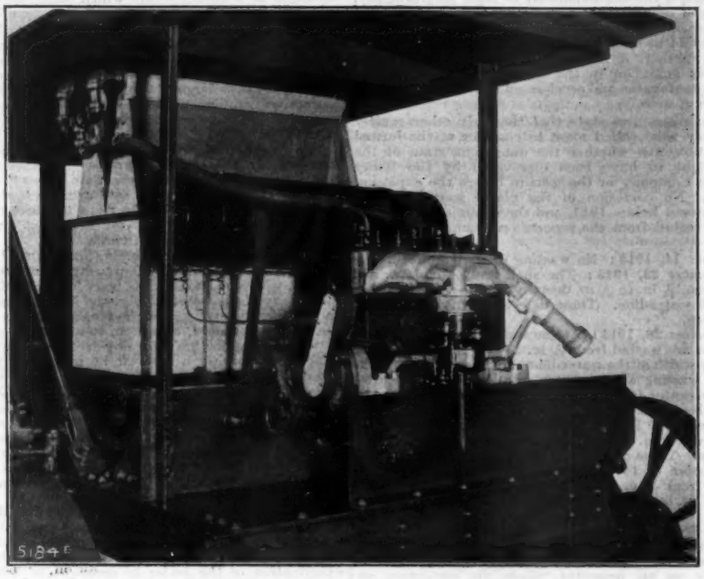


Fig. 4.

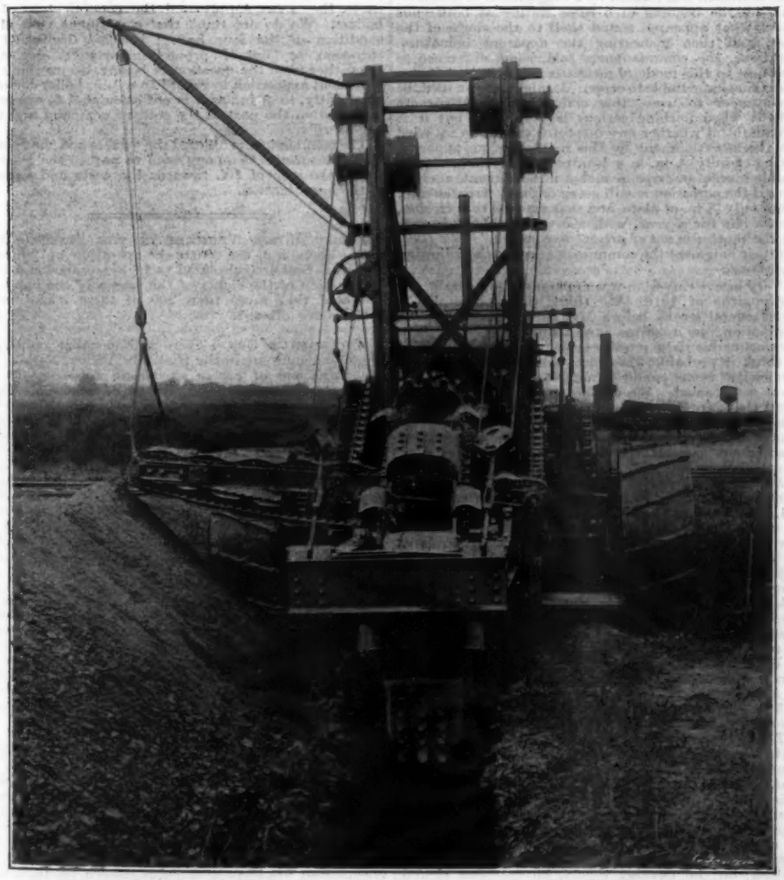


Fig. 5.

The illustrations on page 228 and on the present page show the construction of the petrol farm drainage machines, developed by the Pawling and Harnischfeger Co. at Milwaukee, Wis., U.S.A. These machines are variously constructed. Fig. 1 shows the so-called caterpillar type and Fig. 2 the ordinary tractor type. Fig. 3 is a front view of the tractor type, but fitted with a ladder dredger and not with an excavating wheel as in Fig. 2. In this case the frame which carries the chain of buckets goes down into the trench, and is not kept above it as in Fig. 5, which shows a machine similar to that in Fig. 2. Fig. 4 is a view of the petrol or gasoline engine in Fig. 1. Figs 1, 2 and 5 are equipped with wheel ditchers, in which buckets on a circular frame revolve around guide pulleys. Tile drainage has been carried on for the past 200 years, and while it had a very crude beginning, its benefits have been so well defined that it is to-day an established necessity. In early days logs or poles were used in America, and later plank was utilised in the form of a triangle; then crude forms of tile, until to-day there is employed perfect clay and cement tile for this use. The early drainage was only carried on in order to drain a certain low spot or pond. To-day systematic drainage is carried on, high, as well as low, land being drained. The value of draining was not appreciated so early in America as in this country. Here immense sums were spent in the first half of the nineteenth century, and the production of the land was vastly increased.

The extensive amount of drainage work that has been done recently, and is now under way, is directly due to the vast benefits that have followed the operation elsewhere, and as the supply of hand labour does not equal the demand, different types of machine have been designed to replace this labour, which, furthermore, cannot be depended upon for a perfectly graded trench.

These petrol and oil engine-driven tile drainage machines are stated to have made records in the worst kind of gumbo and sticky soil far in excess of what many other machines have done. The main channel members of the chassis are connected to each other by means of lacing bars, and all connections are made with power-driven rivets. The wheels are carried on stub shafts fitting into a heavy plate spaced between the channels. These shafts can be removed without disturbing any other part, should it become desirable on account of wear, or for any other reason.

The chassis is mounted on the front axles by means of a pin-jointed connection that permits free movement of the axle in passing over uneven ground without affecting the car body proper. This provides, in effect, a three-point suspension, a very desirable feature. The chassis is of structural steel and is so designed that it supports the machinery without any overhanging or eccentric loading. There are no bends in the frame members to weaken them. Cross-bracing is provided to insure rigidity and prevent relative movement of the frame members.

The machines are equipped to burn either gasoline, kerosene or motor spirit, and are provided with a four-cylinder vertical internal-combustion motor. The motor is of the tractor type (Fig. 4), designed for continuous service. The internal-combustion engine used is water-cooled, and circulation is maintained by a centrifugal pump. The tanks are fitted with open screens to insure better cooling, by exposing the water to the air in a thin sheet. Baffle plates are provided in the cooling tanks to prevent the water from flushing over the sides in passing over rough ground.

The machines are steered by means of worm and wheel gears on cross shafts which are chain-connected to the front axle (Fig. 1). All steering chains are cushioned at the axle by means of coil springs.

The grading operations are controlled by power, by means of gearing connected through friction clutches to the hoisting drums. The excavating wheel is lowered by gear, and is controlled by automatic friction band brakes, which are lined with asbestos.

The upright supports, cable sheave supports and connections for the excavating wheel frames are formed by placing two heavy channels back to back (Fig. 1). By using this rigid construction it is possible to do away with all extension guides for the excavating wheel connections, with their inherent troubles due to light connections and light members. The sheaves on the machines are mounted at the sides of the upright frame (Fig. 1), instead of on the top, and are carried on cold-rolled shafting. The centre line of the cable sheaves is in direct line with the bracing of the uprights, which eliminates eccentric strains at this point. The connection between the excavating wheel frame (Fig. 2) and the main frame is by sliding shoe clamps, having a bearing across the full face of the combined channels of the uprights. This insures an easy method of raising and lowering the excavating wheel and gives the largest possible bearing surface on the uprights. This connection also assists in maintaining a rigid position of the excavating wheel when operating in frost, cemented gravel, boulders, or other hard digging.

The excavating wheel frame is made of structural steel in much the same manner as the main car body and is very strongly braced, and rigid and heavy construction is provided at the rear end for attaching the cleaning guard and shoe (Fig. 1). This is very important, since any tendency to give or swing sideways in this

member will make it run sideways and cause a great deal of trouble.

The excavating wheel is of the open type, *i.e.*, it has no axle, and is so arranged as to obtain the maximum depth of trench with the minimum diameter of wheel. This member is constructed of steel angles and plates forged to shape by machinery and true to form. The driving gears or internal racks are of cast steel, and are fastened to the wheel member. The buckets are of heavy plough-steel plate, forged to shape and sharpened at the cutting edge.

The double spade cleaner is stationary, being mounted on the frame. These spades clean the bottom, side and top of the bucket, making it a positive-cleaning digging wheel. On the larger machines steel slat conveyors are provided for delivering the spoil on both sides, but clear of the ditch. In the views shown the conveyor delivers only to one side. The conveyors are adjustable in length to suit the depth of ditch being cut, and are driven from the main wheel driving shaft by means of a pair of bevel gears. The outer ends of the conveyors are adjustable for height. The excavated earth is deposited evenly on one or both sides of the trench. Such an arrangement eliminates the objectionable feature, in the drainage field, when back-filling. Ditches dug with these machines are easily back-filled by ploughing in first one side, then the other.

BOILER EXPLOSION AT BATHGATE.

A FORMAL investigation has been conducted at Bathgate and Edinburgh, under the Boiler Explosions Act, 1882, with regard to a boiler explosion which occurred on January 11 last at Riddoch Hill Colliery, near Bathgate, Linlithgowshire, owned by Messrs. Gavin, Paul and Co., Limited, Edinburgh. The commissioners were Mr. Christopher N. Johnston and Mr. Charles R. Cormack, and there were present: Mr. John Menzies, managing director of Messrs. Gavin, Paul and Co., who appeared for that firm; and Mr. W. Boyd Anderson, solicitor, Glasgow, and Mr. George Ness, chief engineer of the Scottish Boiler Insurance Company, who appeared for that company and for their inspector, Mr. Howat. Mr. Robert Shirkey, of the Scottish Colliery Enginemen and Boilermen's Association, represented that association.

According to the report presented by Mr. Graham, engineer surveyor to the Board of Trade, it appears that the boiler was of the ordinary Lancashire type, 30 ft. long by 8 ft. in diameter, made of steel, tested to 160 lb., and worked at 80 lb. pressure on the square inch. It was made by Messrs. William Arnott and Co., Coatbridge, in 1905, and had been in use for about 11½ years when the explosion occurred. In November, 1915, some slight repairs were effected, and the boiler was tested by hydraulic pressure to 120 lb., but no other repairs of any importance had been made, and there was no evidence that any were called for until corrosion developed in the last year or two.

The boiler was insured by the Scottish Boiler Insurance Company, and was last internally examined by their inspector, Mr. Howat, on November 6, 1916. A working examination was also made by another inspector on December 22, 1916, while the foreman engineer of the colliery company, Mr. Bruce, examined the boiler internally every six weeks, his last examination being made on December 12, 1916.

From the report of the Board of Trade surveyor as given at the investigation it appears that when the explosion occurred the second and third rings of the shell plates ruptured longitudinally to their full width at the water-level on the left side when facing the front of the boiler, forming an opening about 10 ft. in length by four-fifths of the circumference; through this opening the contents of the boiler escaped, wrecking the brick-work flues and the winding engine house. The boiler was forced back about 2 ft., the steam pipes connecting two of the boilers and superheaters to the main range of steam pipes were destroyed and the pieces scattered, while the stop valve of one of the boilers, with about 4 ft. 6 in. of the branch pipe attached, was hurled over the electric engine house, and fell about 180 yards from the boiler, being deeply embedded in the ground. A brick from the brickwork covering of Nos. 1 and 2 boilers was carried to a distance of about 200 yards, passing through the corrugated iron roof and indenting the floor of the weighing-machine house. Fortunately nobody was killed by the explosion, but one engineman sustained slight injuries, whilst a girl employed at the pithead had suffered slightly from shock, but both of them had recovered.

The explosion was due to the wasting of the plates of the boiler through internal corrosion along the water-line, the plates being deeply corroded and the corresponding rivets wasted. The depth of the wasting, the report stated, varied, but the two plates which gave way were reduced to a thickness of from 0.05 in. to 0.13 in., which, the report added, was no useful thickness for such a boiler.

The report presented by the Board of Trade surveyor dealt fully with the defects and the corrosion in the boiler, and in the report issued by the Board of Trade on the official investigation it is stated that, as the result of the warning given by the explosion, the other boilers were all carefully examined, with the result that they were all found to be in a worn condition, and some of them in a very much worse condition than there was any reason to suspect from the result of previous (including some very recent) examinations, and No. 5 boiler was just ready to go as No. 1 had gone. The Board of Trade state "it is amply proved in this inquiry, and indeed it was not disputed by any of the parties, that the corrosion which had occasioned this explosion was due to deleterious water." Full particulars on this point, together with analyses, are given in the report, as well as other details as to the feed-water and the probable source of its pollution, and the commissioners in their judgment say, "We are of opinion that water from the pit should not on any account be further used for boiler purposes, and that it should be rendered impossible to admit it into the dam." Further, it is stated, "the serious corrosion which was going on in the early winter months was probably aggravated and accelerated by the abandonment of the use of soda."

The commissioners state that the only other matter which they were called upon to consider at the formal investigation was whether the dangerous state of the boiler ought to have been discovered by the Boiler Insurance Company or the owners before the explosion occurred. No corrosion of the plates seems to have been observed before 1913, and the commissioners state that the record from the reports on examinations is as follows:—

"*October* 14, 1912: No wasting of shell noticed.

"*September* 22, 1913: The shell and end plates are wasted from $\frac{1}{16}$ in. to $\frac{3}{16}$ in. deep by 5 in. to 7 in. in width about the water-line. These defects are not of present importance.

"*September* 28, 1914: At the water side the shell and end plates are wasted from $\frac{1}{16}$ in. to $\frac{3}{16}$ in. deep by 5 in. to 7 in. in width at the water-line. Our inspector reports that the wasting at the water side has been caused by using feed-water from the pit, but this source of supply has now been discontinued.

"*December* 3, 1915: The shell and end plates were wasted from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. for 5 in. by 7 in. along the water-line. These defects are not of present importance.

"*November* 6, 1916: The shell and end plates are corroded from $\frac{1}{16}$ in. to fully $\frac{3}{16}$ in. deep over a surface 5 in. to 7 in. in breadth. The heads of a number of the rivets in the circular seam at these parts are similarly wasted. These defects are not of present importance."

Mr. Howat, whose training, the commissioners state, was that of a boiler maker, but who had had considerable experience as an inspector, made his inspection on November 6, 1916, in the usual way. He informed the court that he made it carefully and used the "hammer test" in all doubtful places. His estimate of the depth of the corrosion was formed by a rough mode of measurement, by the bending of a ruler resting at both ends against what appeared sound shell to the curve of the boiler, and then measuring the apparent indenture. There was, the commissioners said, some difference of opinion as to this mode of measurement; at best it was approximate and liable to error. It might, they added, be quite proper to use "this and similar approximate methods when nothing serious is suspected, but it is more doubtful whether any inspector should be satisfied with the ascertainment by this method of an apparent wasting of fully $\frac{3}{16}$ in. in a $\frac{1}{2}$-in. plate. $\frac{1}{16}$ in. is a quite possible margin of error in such a measurement, another $\frac{1}{16}$ in., if the corrosion is still going on, may be eaten into, so that only $\frac{3}{16}$ in. of plate, and that exposed to corrosion, may be left for a year, with the comforting assurance that the matter is *not of present importance*."

In their judgment the commissioners gave the following conclusions:—

"Very active corrosion was apparently going on in the later months of 1916. We think this had probably begun several weeks before Mr. Howat had made his examination, as it seems improbable that such deep corrosion as his data require took place in nine weeks. We think it probable, therefore, that the boiler was in a somewhat worse condition on November 6 than Mr. Howat ascertained. We are not constrained, however, to find that Mr. Howat was guilty of wilful carelessness in his examination. The fault, if there was one, appears to have been reliance upon an approximate mode of measurement beyond the limit where such a method was satisfactory.

"It was urged on behalf of Mr. Howat and of the insurance company that a comparison of the results of 1914, 1915, 1916 justified the conclusion that the corrosion was no longer active. There is plausibility in this, but there are counter considerations. In the first place, we think that an apparent corrosion of $\frac{3}{16}$ in. in a $\frac{1}{2}$-in. plate was treated too lightly from 1914 downwards. Again, corrosion of the rivets, not noticed before, is marked in 1916. The mode of measurement we have referred to. Further, Mr. Howat states that he suspected pit water was still being used to some extent, but (and this probably affects the insurance company more than Mr. Howat personally) a conjunct view of the reports down to November, 1916, should have excited suspicion and led to inquiry. The reports on boilers Nos. 2, 3 and 5 in November, 1916, showed corrosion newly begun or progressing.

"The only examination of the boilers other than that of the insurance company was a six-weekly internal examination which Mr. Bruce stated he gave to each boiler. In our opinion Mr. Bruce relied too much on the insurance company's inspection, and only made a perfunctory examination himself. By the time of the explosion the boilers were all getting into a bad state, yet apparently Mr. Bruce noticed nothing. Apart altogether from the boiler here in question, No. 4 boiler, in which, on the October report, no corrosion should have been looked for, was corroded to $\frac{3}{16}$ in. by February 10, and must therefore have been corroded when Mr. Bruce last examined it before the explosion of No. 1."

A number of questions were submitted to the court by Mr. Smith on behalf of the Board of Trade, and these were answered in detail by the commissioners:—"The cause of the explosion was thinning of the shell plates of the boiler by corrosion through the chemical action of unsuitable feed water." With regard to the question of blame as raised by the Board of Trade the commissioners remarked as follows:—

"We do not think that this is a case of gross carelessness, but, on the other hand, we do not regard the explosion as a misadventure which could not well have been avoided.

"1. As regards the colliery company, we think that, after the warning in 1914, they ought either to have seen that the use of pit water was wholly discontinued or to have had the water analysed. More generally we think that they ought, when arranging their different sources of supply, to have had the different waters analysed, and that this should have been done from time to time thereafter if any corrosion appeared.

"2. The same observations apply to the general manager, Mr. Hamilton. He appears to have been more alive to the danger of pit water than either the directors or the engineer and to have been anxious to discontinue its use; but he did not take steps to insist upon total discontinuance or analysis. We suspect it was used to a greater extent than he was aware of.

"3. The manager, Mr. Martin, had been a little more than a year at the mine. He was largely engaged underground, where he had much to learn, and he did not know the history of the water supply, and he had reason to rely on the experienced general manager and the engineer. We are not disposed, therefore, to attach blame to him.

"4. We think that the engineer, Mr. Bruce, took altogether too easy a view of the use of the pit water, and probably turned it on oftener than he admits or even himself now believes. We also think that Mr. Bruce relied too much upon the inspectors' reports. According to his own account he was in one of the six boilers in turn every week. Apart altogether from the boiler here in question, rapid corrosion was going on in two boilers, the shell plates of which had been reported as free from corrosion in the middle of October, but apparently Mr. Bruce noted nothing amiss.

"5. As regards the insurance company and Mr. Howat, we have already expressed our opinion that, in the circumstances, they should not have been content without boring a plate. Further, we think that the results of the examination of the boiler in question, of boiler No. 3 on December 20, 1915, and in November, 1916, of boiler No. 2 on October 30 and November 27, 1916, and of boiler No. 5 on November 13, 1916, should have put the insurance company seriously upon the inquiry as to the water supply and the general state of the boilers. We do not think that a conjunct view of the condition of the four boilers justified dismissing the corrosion as 'not of present importance,' nor, apart altogether from the question of boring, do we think this a prudent expression in regard to a ½-in. boiler corroded, apparently, to $\frac{3}{16}$ in., as it is not calculated to encourage vigilance on the part of the colliery company and their engineer."

The commissioners ordered the owners and the Scottish Boiler Insurance Company each to pay to the Board of Trade the sum of 30*l.* towards the costs and expenses of the investigation.

PUBLIC MOTOR VEHICLES IN THE STATES.—By a recent decision of the courts the operation of "jitney" buses in Seattle is declared to be a nuisance and to be an invasion of the rights of the tramway company. It is stated that more than 200 of these useful public vehicles are affected.

MOLYBDENUM ORE.—There is a peculiar occurrence of molybdenum ore in the Hlatimbe Valley, Natal. The deposit is one of coarse sandstone belonging to the Molteno division of the Karroo system of Upper Triassic age, and is associated with oil-shale, which overlies the sandstone. An analysis of a sample gave 6.53 per cent. of pyrite and 1.85 per cent. of molybdenite.

QUEBEC IRON ORE.—The St. Charles deposit in Quebec is one of titaniferous magnetite, occurring in large segregation masses. The quantity available is estimated from 1,000,000 to 5,000,000 tons. A sample was found to contain 50.53 per cent. of iron, 10.55 per cent. of titanium, with 0.02 per cent. sulphur and 0.03 per cent. phosphorus. By magnetic concentration the iron can be raised to 77 per cent.

RHODESIAN TIMBERS.—Rhodesian teak or redwood resists well the attacks of white ants. Rhodesian mahogany is usually handsomely figured, and is suitable for cabinet work. Bloodwood is used by the natives for boat-building and for paddles. It is a first-class wood for joinery and cabinet work. Mangura is a tough fibrous wood suitable for handles, spokes, &c. The interim report of the Rhodesia Munitions and Resources Committee refers to other and less-known timbers.

NEODYMIUM IN MINERALS.—The amethyst colour which develops in certain glasses when exposed to the sun rays for long periods is rightly ascribed probably to the presence of manganese, though it cannot directly be due, as is sometimes asserted, to permanganates, which could hardly exist in glass and which are, moreover, characterised by peculiar absorption bands, not observed in such glasses. In a communication to the Washington Academy of Sciences (March 19, 1917, issue of the Journal of this Academy) Mr. E. T. Wherry states that the faint reddish-violet tint of some minerals, which are colourless in their purest condition, seems to be due to neodymium, which is likewise characterised by a peculiar absorption spectrum; neodymium gives compounds of that colour, but the percentage of this rare earth in those minerals would be too small for ordinary analysis.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

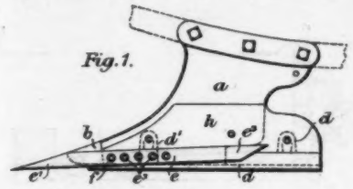
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

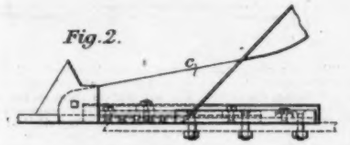
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

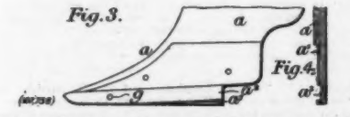
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

AGRICULTURAL APPLIANCES.

107,738. John Wallace and Sons, Limited, Dennistoun, Glasgow, and R. C. Morton, Lanark. Ploughs. (10 *Figs.*) February 3, 1917.—This invention relates to ploughs of the class having steel digging bars, which are removable and also adjustable to take up wear. The object of the present invention is to so construct and arrange the parts that the digging bar will lie in a recess so as to be flush with the land side of the plough, thereby enabling the plough to run correctly and to draw more easily. *a* is the plough body, *b* the share, *c* the mould board, *d* the sole, and *e* the digging bar. Under this invention, with a plough of the construction shown, the digging bar *e*, which is pointed at each end e^1, e^2, as usual, is secured adjustably in place by passing a bolt *f* through one or other of a series of holes e^3 and through the body of the plough. The body of the plough is



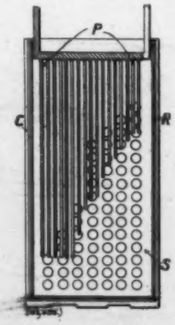




recessed, at the parts a^1, a^2, the part a^2 forming a longitudinal and slightly inclined groove or channel having at its under side a triangular-shaped projection a^3. The bar *e* lies snugly in position in the channel a^2, and the bolt *f* passes through the hole *g*. The bar is held in position at its upper side by a plate *h*, this plate having an angular recess into which the end e^2 of the bar *e* can enter. The plate *h* is secured in position by bolts passed through holes in the plate and the body of the plough. The digger bar is supported and held in position at its under side by the sole *d* which has two lugs d^1, d^2 on it, the one at the one side and the other at the other side, and it is also provided with an upstanding flange. The sole *d*, when fitted in place, has the lugs secured to the body of the plough and the plate *h* respectively by bolts. (*Accepted July* 18, 1917.)

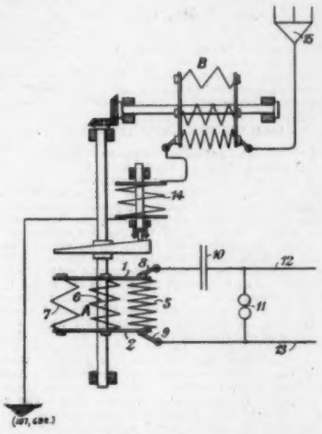
ELECTRICAL APPARATUS.

107,656. B. M. Drake, Westminster, London, and The "D.P." Battery Company, Limited, Bakewell. Electric Accumulator Containers. (1 *Fig.*) July 12, 1916.—The object of the invention is to prevent the spilling of electrolyte



when containers or boxes of electric accumulators are cracked or become leaky. For this purpose the applicants use a lining of thin rubber placed inside the container, which may be in the form of a complete bag, but should this be ruptured the internal pressure maintains close contact, preventing leakage on other parts of the container. Instead of a complete bag a number of separate sheets of thin rubber may be used; even a single sheet of rubber might be sufficient. The rubber used may be vulcanised to some extent, without, however, losing its flexible properties, or where the boxes are deep and the pressure necessitates strengthening it may be composed of two thin layers of rubber with fibre or other suitable reinforcing material interposed. Mechanical protection may be provided in the form of ebonite sheet, preferably perforated, so as not to interfere with the local pressure at the damaged part, or wood strips or other suitable means may be employed to prevent the plates from damaging the lining when being moved in or out of the box. The drawing shows the box C with a lining R of thin sheet rubber, which is protected from damage by the battery plates P by perforated plates S of ebonite. (*Accepted July* 18, 1917.)

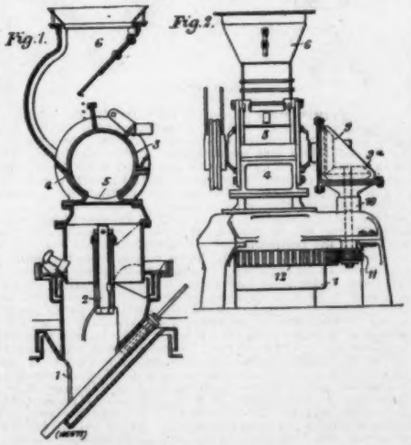
107,682. Indo-European Telegraph Company, Limited, and A. H. Morse, London. Wireless Telegraphy. (1 *Fig.*) August 4, 1916.—This invention relates to electric oscillating or wireless systems and apparatus. A device according to this invention is shown at A, and comprises two rotatable discs 1, 2 of insulating material. Inductances 5, 6, 7 are mounted between the discs so as to be rotatable therewith. Brushes, 8, 9 are adapted to engage the contacts to which the ends of the inductances are connected, these brushes being part of the oscillating circuit comprising the condenser 10 and spark



gap 11, current being supplied over the leads 12 and 13. By rotating the discs 1, 2 any one of the inductances 5, 6, 7 may be connected in the oscillating circuit. The inductances may form the primary winding of a high frequency transformer or jigger having a secondary winding 14. The secondary winding 14 has one end connected to earth and the other end connected to an aerial 15 through a device B similar to the device A. The device B is geared to the device A, so that the required changes in the primary and secondary circuits are made simultaneously. (*Accepted July* 18, 1917.)

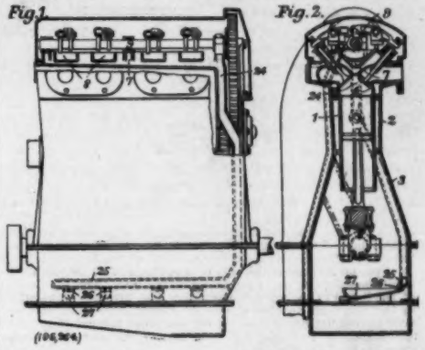
GAS ENGINES, PRODUCERS, HOLDERS, &c.

106,977. A. Sahlin, London. Gas Producers. (3 *Figs.*) March 19, 1917.—This invention relates to charging apparatus for gas producers of the type in which a rotating nozzle or spout-shaped coal distributor is adapted to feed and scatter the coal uniformly over the entire surface of the fuel-bed producer. According to the present invention, a rotating nozzle or spout-shaped distributor is combined with a rotating feed-drum or equivalent mechanism, the two co-acting in such a manner that each intermittent charge dropped from the drum through the nozzle 1 will be deposited by and from the nozzle of the said distributor around the bed of fuel at regular intervals, each



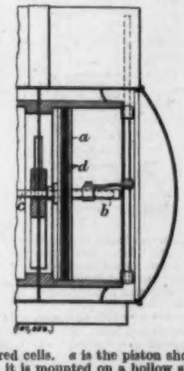
charge dropping at a certain constant radial angle from the previous charge, this angle being the same no matter how fast or how slowly the feed-drum is made to revolve. The constant angle is so chosen that no multiple of this angle will be divisible by 360 deg. By so doing no two charges can be deposited on the same radial line on the bed of fuel, except at very long intervals. The nozzle 1 is supported from a central fixed pivot post 2. Located above is the rotating feed-drum 3, carried in its cradle 4, and provided with a receiving and discharging opening 5, above being a hopper 6 with the known regulating and drum-cleaning devices. The drive of the combined feed drum and nozzle is effected through the friction gear. Motion is transmitted from the drum 3 to bevel, or preferably mitre gears 9, 9a, the latter driving a spindle 10 on which is a pinion 11 engaging a gear wheel 12 of the nozzle 1. (*Accepted June* 20, 1917.)

106,964. G. Scammell and Nephew, Limited, Spitalfields, London, P. G. Hugh, Southend-on-Sea, and C. W. Higgs, Kilburn. Internal-Combustion Engines. (3 *Figs.*) February 1, 1916.—This invention relates to the lubrication of internal-combustion engines. The cylinders 1 are cast integral with their water-jackets 2 and the upper portion 3 of the crank chamber. The cylinder heads 4 constitute a separate casting, and there is formed integrally with it a channel 7, which slopes downwards towards one end. Within this channel there are formed a series of troughs 8, allocated one to each set of cams on the camshaft 9, each set of cams operating the valves for one cylinder. These troughs 8 do not extend to the bottom of the channel 7, but are of a bridge formation, to provide a clear path of flow for the lubricant along the channel. At the lower end of



the channel 7 there opens into it a conduit 24 formed integrally with the various castings for the cylinder heads, cylinders and crank chamber. It extends vertically downwards a short distance from the end of the channel 7 and then, bending to one side, is carried obliquely down to the side wall or corner of the crank chamber. At its lower end it opens into a horizontal tubular conduit 25 formed integrally with the lower part of the crank chamber. This conduit 25 extends lengthwise of the crank chamber and is provided with a series of jets or tubes 26 situated above sloping troughs 27. These troughs are arranged one under each crank of the engine, and are so positioned that an oil scoop on the big end of each connecting rod dips into it to lift oil therefrom in the usual method of splash lubrication. Any oil overflowing from the troughs 27 is collected in a sump in the crank chamber provided with a suitable filter or strainer. (*Accepted June* 20, 1917.)

107,628. W. Alexander, and Pinchbeck, Limited, Holloway, London. Dry Gas Meters. (1 *Fig.*) July 3, 1916.—This invention relates to the pistons of dry gas meters. According to this invention, the piston has a groove which may be divided into cells filled with mercury, which moves to and fro with the piston over the walls of the cylinder. Any tendency of the mercury to move out of its groove is checked by the pressure of the fluid exerted in the direction in which the piston is moving. It is desirable, and sometimes necessary, to provide the piston with a number of grooves and to divide up the grooves into a



number of staggered cells. *a* is the piston shown in its extreme inward position; it is mounted on a hollow shaft *b*, and moves to and fro on a spindle *c*. The piston is provided with three grooves divided up into a large number of cells *d*, *d*. The cells in the outer grooves are staggered with regard to the cells in the central groove. To fill the grooves or cells with mercury, the cylinder is provided with a hole through which mercury is poured when the grooves are opposite it, the piston being also rotated when a groove is divided into cells. (*Accepted July* 18, 1917.)

MINING, METALLURGY AND METAL WORKING.

107,734. G. Constantinesco, Alperton, and W. Haddon, London. Rock Drills. (7 *Figs.*) July 3, 1916.—The present invention relates to rock drills adapted to be driven by alternating currents produced in liquid columns. The invention consists in a drill comprising a reciprocating part reciprocated by alternating currents in the transmission line and rotated by the alternating currents in the transmission line. The drill casing is mounted in guides in a cradle 30, along which it is fed forward by the feed screw 31. The drill bit 32 is held in the chuck 34, which is formed in one with the piston 35. The piston 35 slides in a bearing 36 in the casing, and carries a cup-shaped spring abutment 37 having an outwardly projecting flange so that it forms an abutment for the two springs 39, 40, which are adapted to hold the piston in a mean position about which it can oscillate. The springs are of such strength that the piston is in equilibrium, under their action and the mean pressure in the wave transmission line, in the position which it occupies at the moment the blow is struck when drilling. The wave transmission line is connected to the inlet 41, and the whole of the space behind the

piston is filled with liquid, which passes through the passage 42 to the annular groove, from which it can pass to the whole of the outer space 44, and so to the back of the piston. The piston is hollow and has at its rear end an aperture 45 which works over a conically-shaped needle 46 so that a small leak is allowed through this aperture and so to the interior of the piston, whence it passes down the hollow bit to provide a spray for washing out the boring. On the outside of the drill piston there is mounted a ratchet-piece 47 with internal keyways to fit splines on the end

Fig. 1.

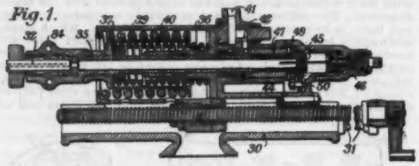
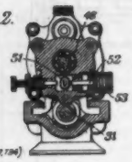
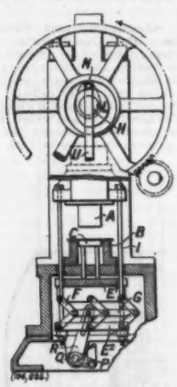


Fig. 2.



of the piston. The end of the ratchet-piece is provided with face teeth adapted to engage with face teeth on the rotor ratchet-piece 49, which carries a pin 50 engaging with a Scotch yoke 51 on a piston 52 pressed inwards by a spring 53 and subject to the liquid impulses in the wave-transmission line. The oscillations of the liquid in the wave-transmission line are thus transmitted to the piston 25 to give it a reciprocating movement and also give an oscillating movement to the rotor ratchet-piece, thus intermittently rotating the drill in one direction. (*Accepted July* 18, 1917.)

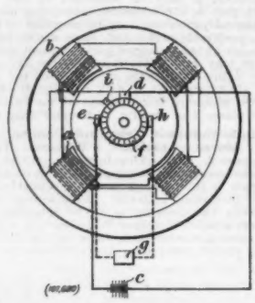
104,686. E. W. Bliss Company, Brooklyn, New York. Drawing Presses. (5 *Figs.*) March 8, 1917.—This invention relates to drawing presses adapted to draw shells of various shapes from metal blanks. The object is to provide a construction of machine wherein the presser-foot or blank-holder is caused to firmly clamp the work against the punch or plunger during the drawing operation and prevent the presence of any surplus metal at the bottom of the stamping. Thereupon, after the plunger is withdrawn from frictional contact with the stamping, the blank-holder, by an independent motion, discharges the stamping from the die. The press has a reciprocating plunger A, a stationary die B, and a movable blank-holder C. The blank-holder is mounted upon a blank-holder frame, which is composed of two relatively movable parts, to wit, an upper



frame E1 upon which the blank-holder C is mounted, and a lower frame E2. These two frames are connected by toggles F. The links of the toggles are joined together by a toggle link G. The blank-holder frame is moved from the plunger-operating crank-shaft H, and the connection accomplished by means of connecting rods I. The means whereby the toggles F are controlled, so that the blank-holder may move in unison with the plunger during the drawing operation and independently thereof when acting as a knock-out, comprise a revolving cam L associated with the crankshaft H. This cam is formed so as to give the desired motion to a stationary cam roller N, which is attached by link U to rocking-arm P, which is keyed on rocking-shaft Q. Fixed upon the shaft Q is a toggle-operating rocking-arm R connected with the toggle link G. (*Accepted July* 18, 1917.)

MOTOR ROAD VEHICLES.

107,680. A. H. Midgley and C. A. Vandervell and Co., Limited, Acton Vale. Combined Starter and Lighting Dynamoes. (3 *Figs.*) July 28, 1916.—This invention relates to a combined starter and lighting dynamo, of the type in which a single armature provided with one armature winding and one commutator only is employed. The main feature of the present invention consists in the provision of two commutator brushes of the same polarity with an automatic cut-out inserted between them, one of these brushes being disconnected when the machine is running as a dynamo, preferably by its being moved away from the commutator. The field magnet of a four-pole machine is provided with a series and a shunt excitation winding *a* and *b* respectively, the positive pole of the battery *c* being connected to one commutator brush *d* and the negative pole thereof being connected through the series field excitation winding *a* to a commutator brush *e*, which is capable of being lifted off the commutator *f* when required, and through the series field winding and the automatic cut-out *g* to another commutator brush *h*, the two brushes *e* and *h* being preferably arranged diametrically opposite each other and at 90 deg. relatively to the brush *d*, which is connected to the positive pole of the battery. In order to obtain a constant output one end of the shunt field excitation winding *b* is connected to the positive brush *d*, whilst the outer end thereof is connected to a brush *i*, which is preferably arranged between the positive brush *d* and one of the negative brushes, preferably the movable negative brush *e*. When the machine is running as a motor the movable negative brush *e* rests on the commutator *f*, whereby the automatic cut-out *g* is rendered



inoperative and the heavy starting current is prevented from passing through the same. When the machine is running as a dynamo the movable negative brush is lifted off the commutator, thereby leaving the automatic cut-out in the circuit between the dynamo and the battery. (*Accepted July* 18, 1917.)

RAILWAYS AND TRAMWAYS.

107,638. A. H. Johnson, Epsom. Railway Barrier Gates. (2 *Figs.*) July 4, 1916.—This invention relates to apparatus for operating railway barrier gates, and is more particularly applicable to apparatus of the electro-hydraulic type in which an electric motor drives a pump enclosed in a supply reservoir and which delivers liquid to the moving element of a hydraulic motor connected to the barrier gates. A rotary pump 1 of the cog-wheel type, driven by an electric motor, is combined in a single casing 3 with a hydraulic motor 4 of the vane type, connected to the barrier gates and with a controlling valve arranged so as to control the flow of the liquid from the pump 1 to the motor 4, the casing 3 being also formed as to constitute a reservoir for the operating liquid acted upon by the pump. The liquid is forced into a channel 7 which leads to a valve casing 8 of the controlling valve, by which the liquid can be directed to either side as desired of the vane motor 4. Relief valves 10 are provided in the channel 7, so arranged that on the pressure in the channel reaching a predetermined amount, the valves will open and admit the liquid flowing from the delivery side of the pump directly to the oil reservoir 3. The valve 9, which, according to this invention, is provided for controlling the movement of the barrier gates, is a rotary plug. The controlling valve plug 9 is provided with interconnected passages 11, 12, 13, 14 co-acting with ports 15, 16, 17 in the valve casing, and with ports 18 and 19 in the casing of the vane motor 4. Recesses 20 and 21 are also formed in the valve plug 9 adapted, in certain positions of the valve, to connect ports 18 and 19

Fig. 1.

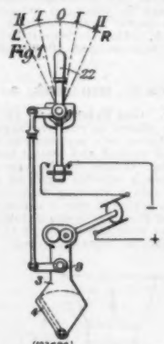
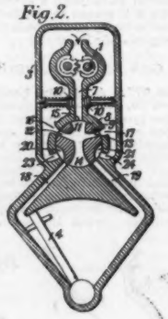


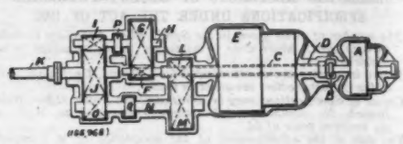
Fig. 2.



respectively with ports 23 and 24, and thus with the interior of the liquid reservoir 3. The operating lever of the valve 9 may have any desired number of operative positions corresponding to the conditions and requirements in each particular case. With double barrier gates of the usual kind it has been found convenient in practice to provide a central neutral position of the operating lever 22 and two operative positions on each side of the neutral position corresponding to the dotted lines O, I, II, and arrows R, L, shown in Fig. 1, in which the operating lever 22 occupies its neutral position O. The corresponding neutral position of the controlling valve 9 is that shown in Fig. 2. In this position the whole of the liquid coming from the pump 1 is returned by valve passages 12 and 13 to the pump reservoir 3, and thence to the pump inlet port. When the operating lever 22 is moved to its first operative position I, R, for example, the ports 16 and 17 are partly closed, the port 18 is partly opened to the delivery side of the pump 1, and the port 19 is partly opened to the liquid reservoir 3. A part of the liquid is therefore by-passed through ports 16 and 17 to the reservoir 3, and another part of the liquid is supplied to the vane motor 4, which is thus set slowly in motion, and imparts a corresponding movement to the barrier gates. On the operating lever 22 being moved into its second operative position II, R, the valve plug is brought into the position which the ports 16 and 17 are entirely closed, and the vane-motor ports 18 and 19 are fully opened; in this position of the valve the whole of the liquid is passed through the vane motor, the speed of which consequently increases and accelerates the movement of the barrier gates. (*Accepted July* 18, 1917.)

SHIPS AND NAUTICAL APPLIANCES.

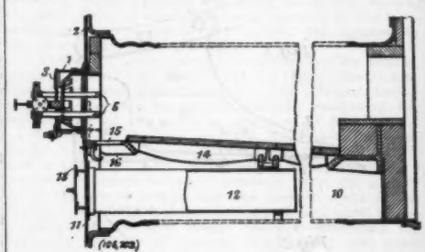
106,968. H. E. Yarrow, Scotstoun, Glasgow. Propulsion of Vessels. (4 *Figs.*) February 5, 1917.—According to the present invention, in which two or more engines can drive separately, or in combination, the same propeller through the medium of a hollow shaft, and in which gearing is interposed between the main and propeller shafts, the axes of the engines are arranged in the same line. This arrangement enables greater stiffness and structural strength to be obtained in the combined plant and preserves the alignment of the shafting even under severe working conditions. A is a high-pressure turbine connected by a coupling B to a shaft C, which rotates in the hollow shaft D of the low-pressure turbine E. On the shaft C is a pinion F, gearing with a wheel G on a second motion shaft H,



which drives through a pinion I a wheel J on the propeller or thrust shaft K. On the hollow shaft D of the low-pressure turbine E is a pinion L, gearing with a wheel M mounted on a second motion shaft N, which drives through a pinion O the wheel J. Suitable flexible couplings may be provided on the second motion shafts at P and Q. (*Accepted June* 20, 1917.)

STEAM-ENGINES, BOILERS, EVAPORATORS, &c.

106,703. C. Zuiver, London, and L. E. Smith, South Shields. Furnaces. (4 *Figs.*) June 30, 1916.—This invention relates to furnaces burning either liquid or solid fuel as desired, and consists in the construction of furnace front, combined with air-supply tubes disposed within the ash-pit and attached to a removable plate which closes the ash-pit. According to this invention, the furnace front comprises a suitably shaped attachment 1, bolted to the furnace front plate 2, and closed at the front by a sliding plate 3 capable of being moved along supports to adjust auxiliary air admission to the fuel burners 5. The burners are mounted upon a box furnished with distributing valves for regulating the fuel supply. The lower half or ash-pit 10 of the furnace is closed by a portable plate 11, in which one or more tubes 12 are fitted extending into the ash-pit. Through



these tubes the principal amount of air is introduced to the furnace for combustion. The amount of air is regulated by means of sliding doors 13. The air travels through the tubes and returns to the front of the furnace, where it impinges upon the fire bars 14 and becomes heated before mixing with the burner spray. The heated air enters the furnace through the opening 15 formed in the dead plate 16, and then meets the fuel spray at right angles or nearly so, whereby a thorough admixture of air and fuel is obtained. The sole object of the air tubes 12 is to provide a convenient method of heating the air supporting combustion before mixing with the fuel spray, hot air being an essential condition to obtain complete and smokeless combustion of liquid fuel, the air also keeping the fire bars cool. (*Accepted June* 13, 1917.)

106,704. C. Zuiver, London, and L. E. Smith, South Shields. Furnaces. (4 *Figs.*) June 30, 1916.—This invention relates to furnace fronts. According to the present invention, the air, instead of directly issuing into the furnace, passes into the furnace front around the burner or burners and thence flows towards the fuel spray. The furnace front *a* is formed with a fuel-supply opening 1, around the upper portion of which is an air passage 2. The upper wall of passage 2 is formed with air

Fig. 1.

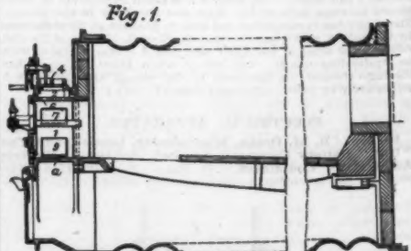
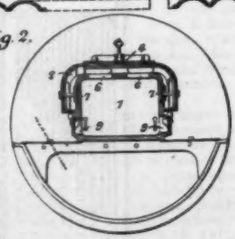


Fig. 2.



inlets, which are opened and closed by a slide 4 operated from the exterior of the furnace front. In the lower wall of the passage 2 and opposite to the air inlets are openings 6 through which air enters the fuel opening 1. This lower wall of the air passage 2 is also formed with oppositely disposed openings 7, closed by doors. Below the closed ends of the passage 2 are openings 9, formed in the wall of the fuel-supply opening 1 and closed by pivotally mounted doors. (*Accepted June* 13, 1917.)